# UEISim User Manual 2.9

April 2014 Edition

The High-Performance Alternative

Table of contents

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# 1. Introduction

UEISim turns a PowerDNx Ethernet data acquisition module into a target on which you can run Simulink models and read/write physical I/Os.

The UEISim host software uses the Simulink add-on "Real-time Workshop" to convert your Simulink model to C code and then cross-compiles it into an executable that runs directly on the UEISim hardware.

You can access all the analog I/Os, digital I/Os, counter timer I/Os offered by PowerDNA from your Simulink model.

You can experiment with control system design, signal processing, data acquisition and similar tasks directly from the Simulink environment using its powerful block library without the need to use any additional tool.

# 2. Software Installation

The UEISim software runs on a Linux PC or on Windows.

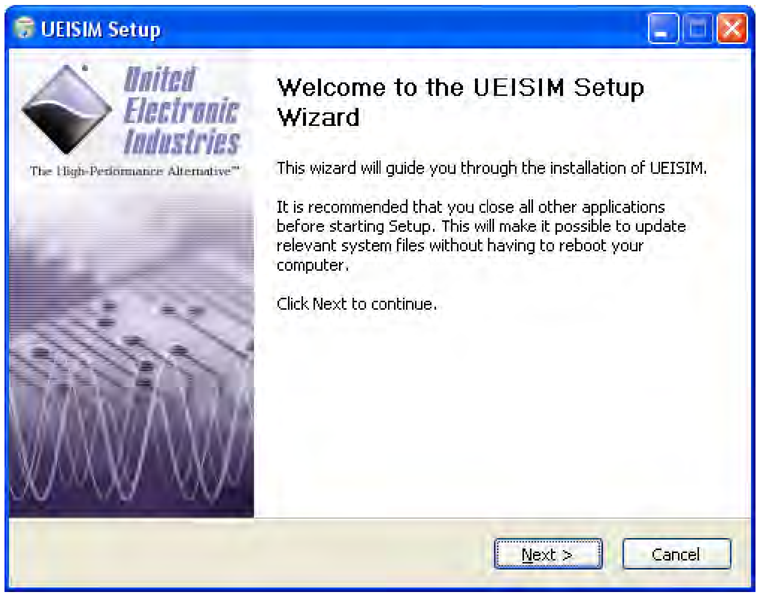
## *2.1. Pre-requisites*

Before installing the UEISim software make sure that the following software is installed on your computer:

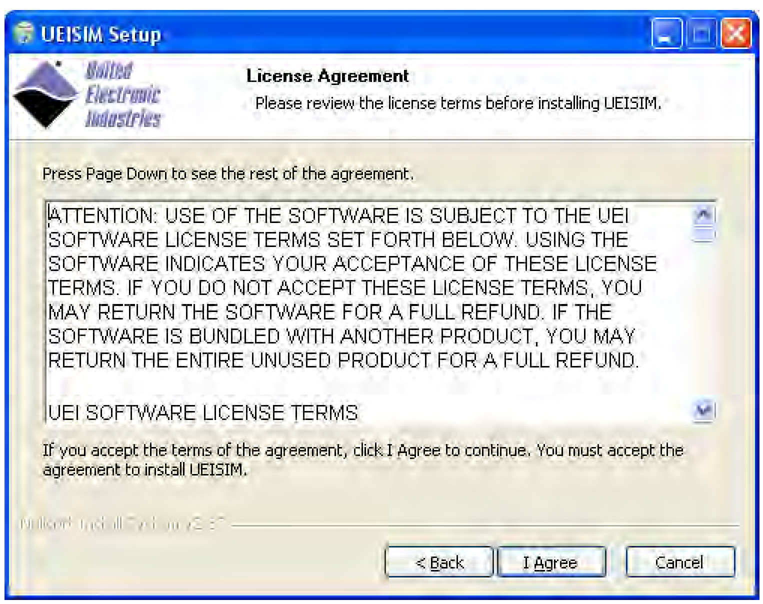
- Matlab R2007b, R2008a, R2008b, R2009a, R2009b, R2010a, R2010b, R2011a, R2011b, R2012a, R212b, R2013a
- Simulink
- Real-time Workshop (for older versions of matlab) or Simulink Coder (for version r2011a and up)

## *2.2. Install UEISim Software for Windows*

Insert the UEISIM Software CDROM in your CD drive. If the installer doesn't start automatically (it depends on whether autorun is enabled or disabled on your PC) run the ueisim_installer.exe program on the CD-ROM.




Click on Next to move to the next wizard page.




Read the license agreement and click on “I Agree” if you accept the terms of the agreement.

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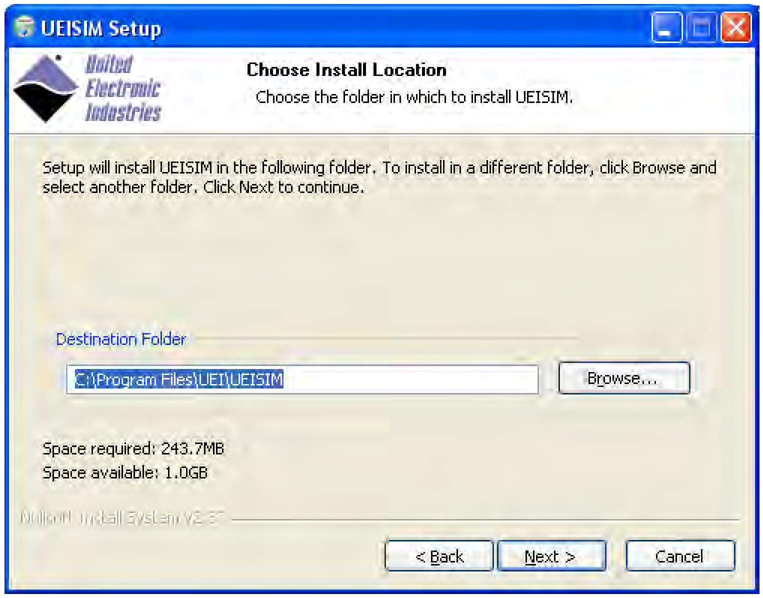
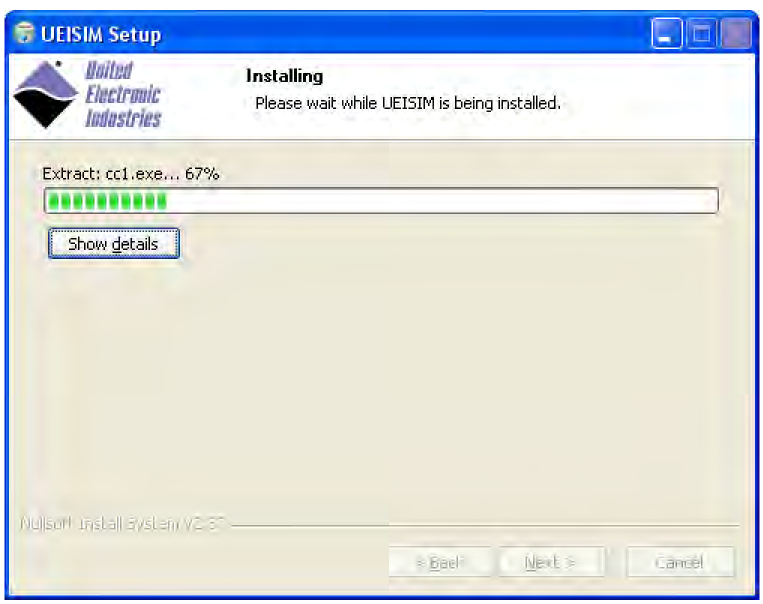
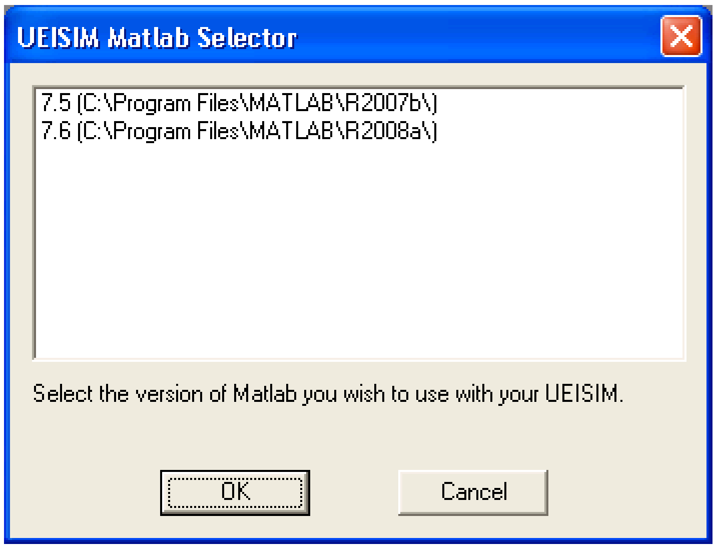


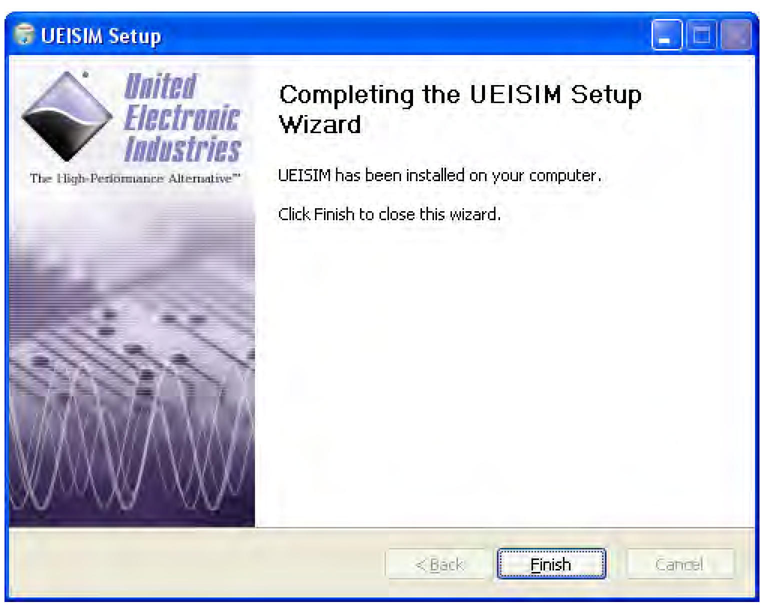

Select the location on your hard drive where you wish to install the software then click "Install". You need to have at least 250MB of free space.




Once the files are installed, the "UEISIM Matlab Selector" applet will pop-up, letting you select which version of Matlab/Simulink you wish to use with your UEISIM.




After the installation is done, you can run that applet again if you want to configure another version of Matlab/Simulink to work with your UEISIM.
You can run the "UEISIM Matlab selector" using the shortcut in the Start/Programs/UEI/UEISIM menu.




Once all the files are installed, click on "Finish" to exit the installer.

**Important Note:** In a few rare occasions, we encountered a problem where the Matlab's ActiveX automation server was not properly registered which prevented our "UEISIM Matlab Selector" applet to work.
When that happens the "UEISIM Matlab Selector" applet will pop-up an error message and you will need to manually configure Matlab's path:
Start Matlab and at the prompt enter the following commands (change the path to the location you selected during the installation):

```
addpath(`c:\program files\uei\ueisim\simulink`)
savepath
```

### 2.3. Install UEISim Software for Linux

Insert the "UEISim" CDROM in your CD drive. You might need to mount it if your Linux distribution doesn't detect the CDROM automatically.
To mount it, type:

```
mount /dev/cdrom /mnt/cdrom
cd /mnt/cdrom
bash install.sh
```

## 3. Configuring the UEISim

The IP address must be configured using the serial port.

### 3.1. Connecting the serial port console

Connect the serial cable to the serial port on the UEISIM cube and the serial port on your PC.

You will need a serial communication program:

- Windows: ucon, MTTTY, putty.
- Linux: minicom or cu (part of the uucp package).

The PowerDNA I/O module uses the serial port settings: 57600 bits/s, 8 data bits, 1 stop bit and no parity. Run your serial terminal program and configure the serial communication settings accordingly.

Connect the DC output of the power supply (24VDC) to the "Power In" connector on the PowerDNA cube and connect the AC input on the power supply to an AC power source.

You should see the following message on your screen:

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```
U-Boot 1.1.4 (Jan 10 2006 - 19:20:03)

CPU:   MPC5200 v1.2 at 396 MHz
       Bus 132 MHz, IPB 66 MHz, PCI 33 MHz

Board: UEI PowerDNA MPC5200 Layer
I2C:   85 kHz, ready
DRAM:  128 MB
Reserving 349k for U-Boot at: 07fa8000
FLASH:  4 MB
In:    serial
Out:   serial
Err:   serial
Net:   FEC ETHERNET

Type "run flash_nfs" to mount root filesystem over NFS

Hit any key to stop autoboot:  5

## Booting image at ffc10000 ...
   Image Name:   Linux-2.6.16.1
   Created:      2006-11-10  16:07:06 UTC
   Image Type:   PowerPC Linux Kernel Image (gzip compressed)
   Data Size:    917636 Bytes = 896.1 kB
   Load Address: 00000000
   Entry Point:  00000000
   Verifying Checksum ... OK
   Uncompressing Kernel Image ... OK
id mach(): done
...
< lots of kernel messages >
...
BusyBox v1.2.2 (2006.11.03-19:16+0000) Built-in shell (ash)
Enter 'help' for a list of built-in commands.

~ #
```

You can now navigate the file system and enter standard Linux commands such as ls, ps, cd…

## 3.2. Configuring the IP address

Your UEISIM cube is configured at the factory with the IP address 192.168.100.2 to be part of a private network.

You can change the IP address for the current session using the command:

```
setip <new IP address>
```

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## 3.3. File system

The UEISIM file system contains the libraries, executables and configuration files needed to make the system functional.

By default, the file system is stored on the SD card inserted on the front panel of the UEISIM.

The file system can alternatively be located in a RAM drive loaded from the FLASH memory or loaded from a remote server using the NFS protocol.

The standard UEISIM file system is read/write to ease the configuration and allow uploading of model files during the development phase.

Once a model is stable, it is recommended to convert the file system to read-only mode to render the UEISIM file system resilient against un-scheduled shutdowns.

### 3.3.1. Booting the SD card with system partition read-only

The procedure below converts the standard UEISIM file system to a read only one.

1. Edit /etc/fstab as below to mount a RAM disk at /var (ram disk maximum size is set to 2MBytes):

```
/dev/sdcard1     /           ext3    defaults,noatime    1   1
none             /proc       proc    defaults            0   0
none             /sys        sysfs   defaults            0   0
none             /dev/pts    devpts  defaults            0   0
tmpfs            /var        tmpfs   defaults,size=2M    0   0
```

2. Create a new script /etc/varsetup.sh with the content below. It setups the folders needed in /var and maps a few writable folders at /tmp, /mnt and /home

```
mkdir /var/tmp
mkdir /var/log
mkdir /var/lib
mkdir /var/lib/misc
mkdir /var/spool
mkdir /var/spool/cron
mkdir /var/spool/cron/crontabs
mkdir /var/run
mkdir /var/lock
mkdir /var/mnt
```

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```
mkdir /var/home

mount --bind /var/tmp /tmp
mount --bind /var/mnt /mnt
mount --bind /var/home /home
```

3. Edit /etc/inittab as below to execute varsetup.sh

```
# Mount all filesystem listed in /etc/fstab
::sysinit:/bin/mount –a

# Create and mount non-persistent folders
::sysinit:/etc/varsetup.sh

# Configure local network interface
::sysinit:/sbin/ifconfig lo 127.0.0.1 up
::sysinit:/sbin/route add -net 127.0.0.0 netmask 255.0.0.0 lo

# run rc scripts
::sysinit:/etc/rcS

# Start a shell on the console
ttyS0::respawn:-/bin/sh

# unmount root file system when shutting-down
::shutdown:/bin/umount -a -r
```

4. Create symbolic links to files stored in /etc that need to be kept writeable.

```
ln –s /var/resolv.conf /etc/resolv.conf
ln –s /var/layers.xml /etc/layers.xml
```

5. Connect the console serial port, power-up the UEISIM and press a key to enter U-Boot. Type the following commands to load the root file system read-only:

```
setenv bootargs console=ttyS0,57600 root=62:1 ro
saveenv
reset
```

### 3.3.2. Restoring or creating a new the SD card

Restoring or  initializing a new SD card can only be done on a Liunx PC (real or virtual).

*1.* Locate the SD card image file rfs-x.y.z.tgz on your UEISIM CDROM as well as the script containing the sequenece of commands to partition, format and initialize a new SD card.

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2. Connect the SD card via a USB adapter (or directly if your computer has a built-in reader).
3. Type the command ***dmesg*** to find out what device node is associated with the SD card. (Linux kernel outputs messages when it detects a new removable drive)
4. Assuming that /dev/sdb is the SD card device node, type ***./createsdcard.sh /dev/sdb rfs-x.y.z.tgz*** to partition, format and copy files to the card.

#### 3.3.3. Booting from a RAM drive (no SD card needed)

Booting from a RAM disk is faster than any other method. However the RAM disk size is limited to 16Mbytes and any data written to the RAM disk is lost when the system shuts down or reboot.

The RAM disk can only fit in the flash memory of the UEIPAC models based on the 8347 CPU (UEIPAC-1G or UEIPAC-R ).

Uploading the RAM disk image must be done from the boot loader command line using the TFTP protocol. Make sure you have a TFTP server running on your workstation.

Follow the steps below to upload the RAM disk to memory and boot from it

5. Connect a serial cable to your UEISIM and start a serial terminal software with communication settings set to 57600,8,N,1
6. Copy <UEISIM_INSTALL_DIR>/rfs/uRamdisk-x.y.z file to the root directory of your TFTP server
7. Power-up the UEISIM and press any key to enable the boot loader command line. You should see the prompt '=>'
8. Configure the UEISIM's IP address
   ```
   setenv ipaddr <IP address of the UEISIM>
   ```
9. Configure U-Boot to use your host PC as TFTP server:
   ```
   setenv serverip <IP address of your host PC>
   ```
10. Upload RAM disk:
    ```
    tftp 4000000 uRamdisk-x.y.z
    ```
11. Copy the RAM disk to flash:
    ```
    erase fe200000 fe7fffff
    cp.b 4000000 fe200000 ${filesize}
    ```
12. Update **bootargs** variable to tell the kernel that its root file system is a RAM disk:

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For 5200 based UEISIM*:*
*setenv bootargs console=ttyPSC0,57600 root=/dev/ram0 rw*
For 8347 based UEISIM:
*setenv bootargs console=ttyS0,57600 root=/dev/ram0 rw*

13. Change boot command to unpack the RAM disk in memory before starting the kernel:
For 5200 based UEISIM, RAM disk must be loaded from RAM
*setenv bootcmd bootm ffd50000 4000000*
For 8347 based UEISIM RAM disk can be loaded from flash
*setenv bootcmd bootm fe000000 fe200000*

14. Save environment to make those changes permanent and reset:
*saveenv*

# 4. Using UEISim add-on from MATLAB/Simulink

## 4.1. Configuration

Start MATLAB then click on the Start button at the bottom left corner of MATLAB's window.

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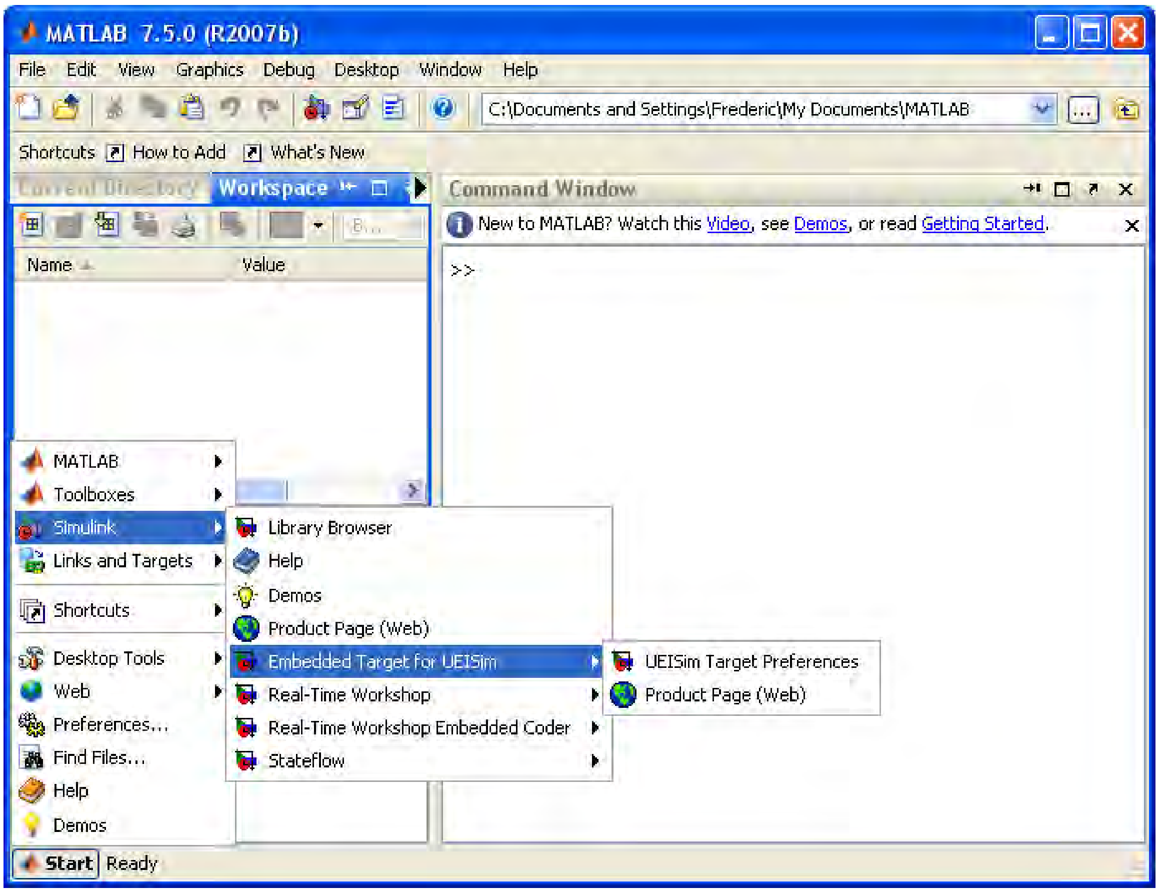
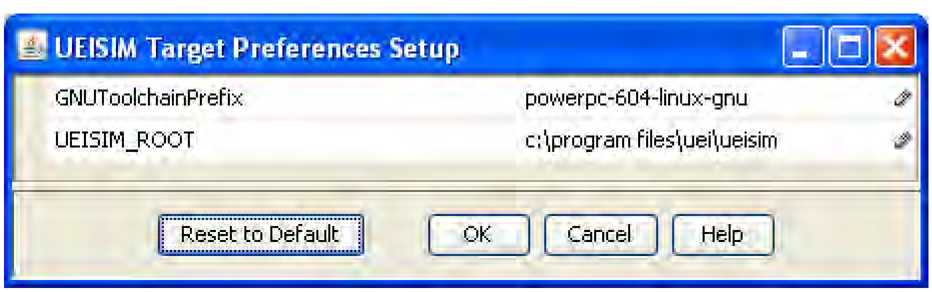



Select Simulink/Embedded Target for UEISim/UEISim Target Preferences

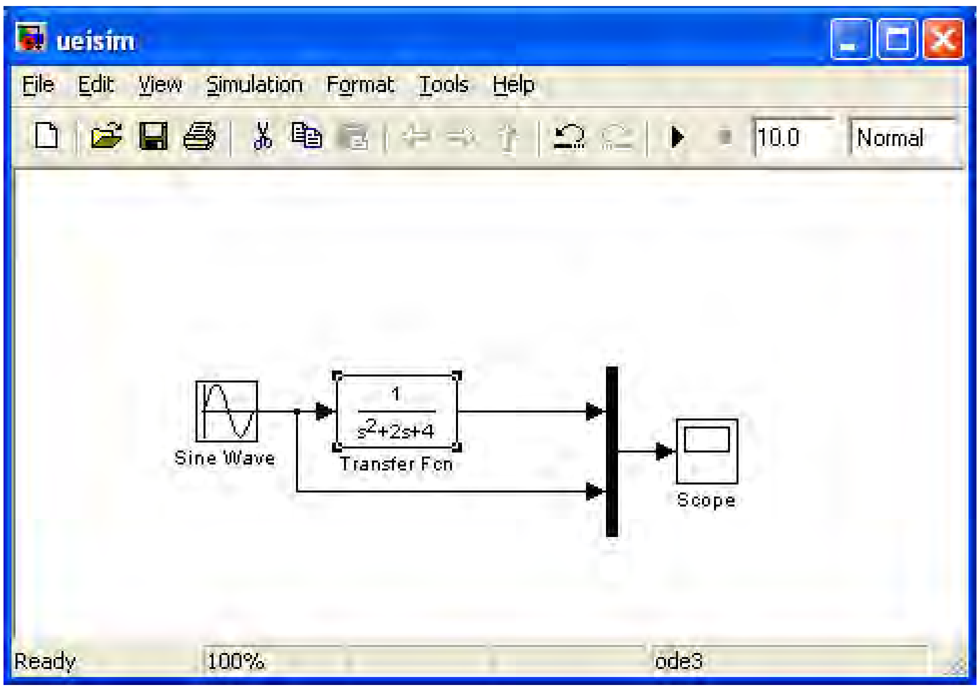



GNUToolchainPrefix: specifies the name of the cross-compiling tools used to build a model to a binary that can run on the UEISIM. The default value is correct, don't change it unless told by UEI technical support.

UEISIM_ROOT: The location of the folder where you installed the UEISIM software. Make sure it matches the folder you specifed while running the UEISM Software installer.

### 4.2. Convert your model

Let's start with an existing model that process some input signal and view the output on a scope.




In order to test our model with a real signal, let's use the UEISim analog input and output blocks.

The UEISim I/O blocks are located in the Simulink library:

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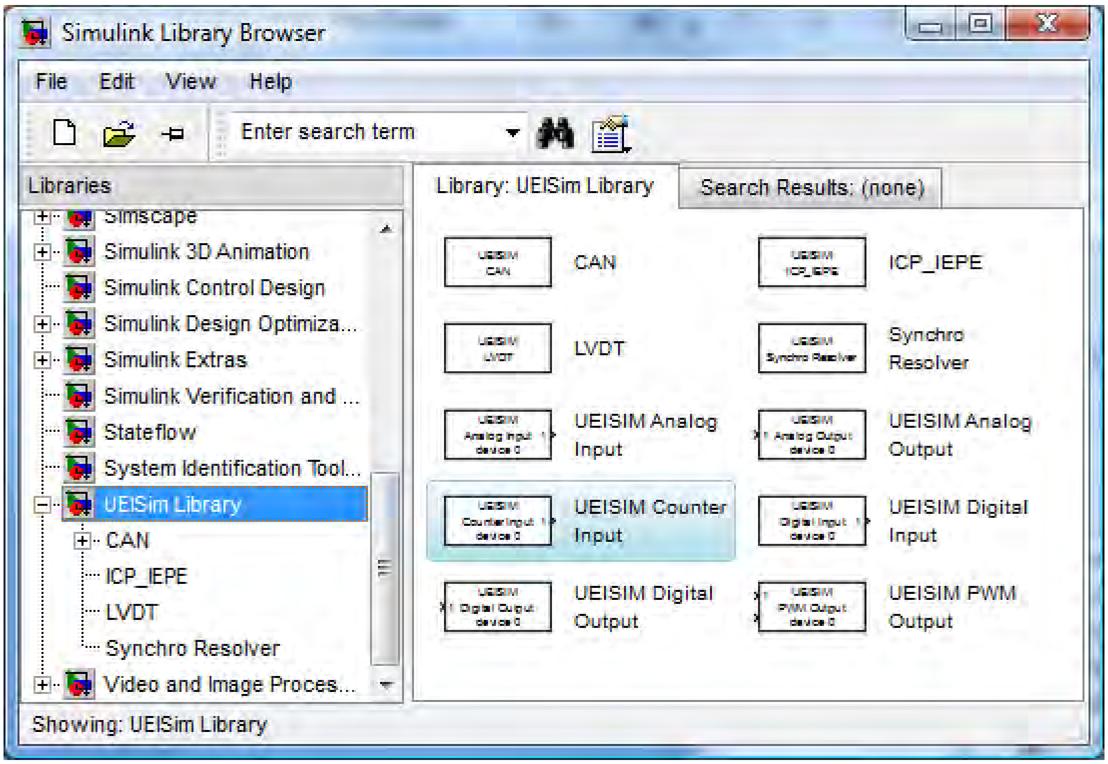
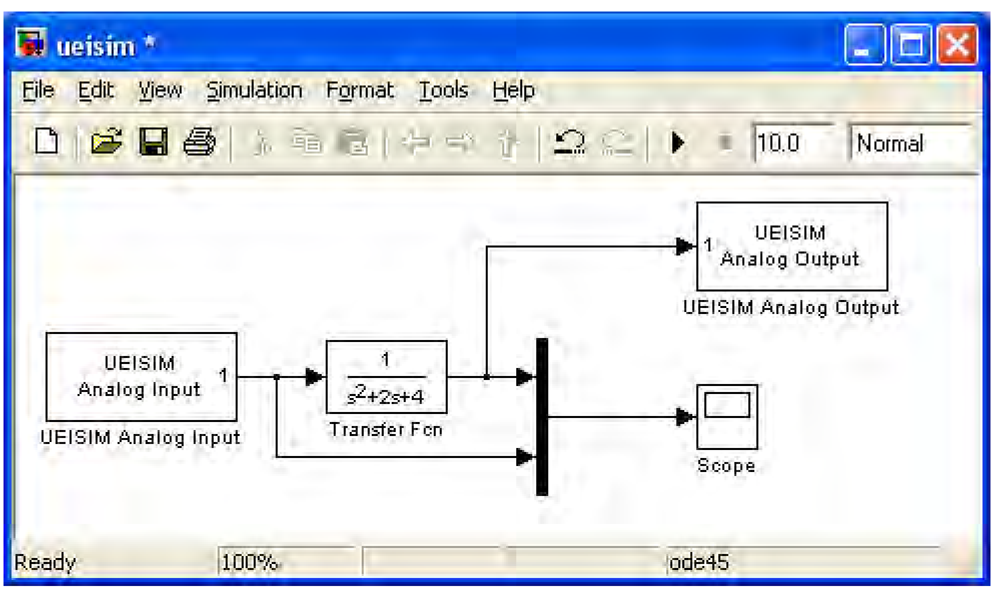



Replace the input sine wave block with an Analog Input block and add an Analog Output block to generate the result as well as display it on the scope.



Double-click on the Analog Input and Output blocks to configure the parameters (see chapter 5 for details on the parameters for each of the UEISIM block).

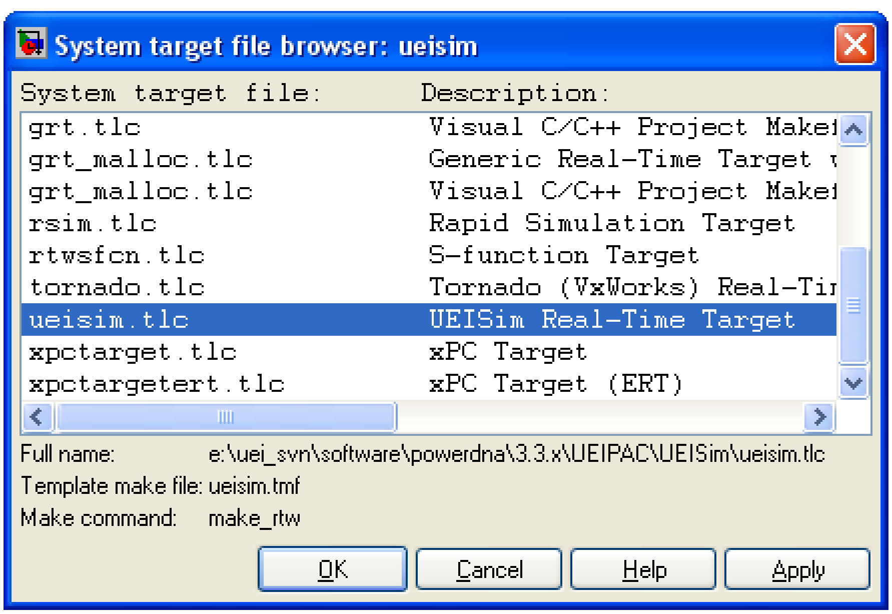
### 4.3. Create an executable from the model

Select the menu option "Simulation/Configuration Parameters…"

Click on the "Solver" option on the left pane and make sure the solver type is set to "Fixed-step".

If you are running a Matlab version earlier than R2012a, Select the **Real-Time Workshop** option then click on **Browse…** to change the system target file.

For Matlab R2012a and later, select the **Code Generation** option then on **Browse…** to change the system target file.




Select the **UEISim Real-Time Target** and click OK.

For Matlab R2012a and later, select the **Code Generation/Interface** option and make sure **Classic call interface** is enabled.

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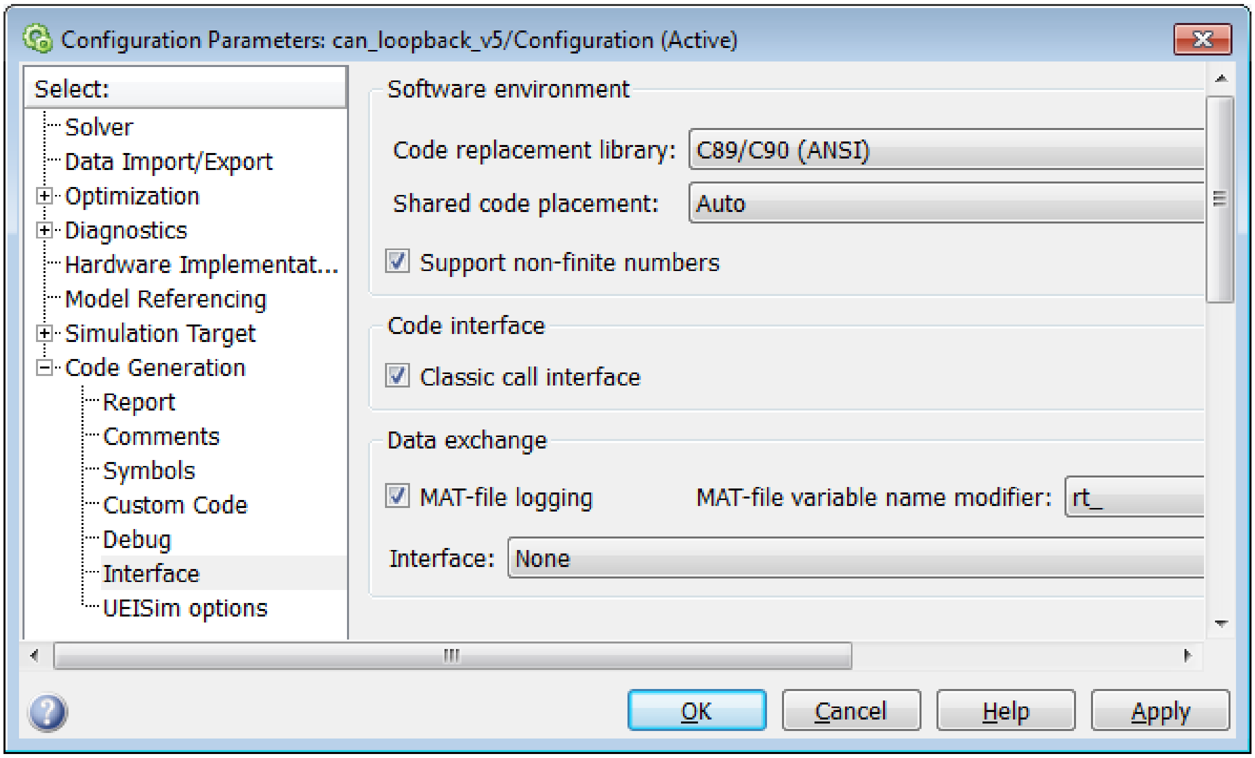
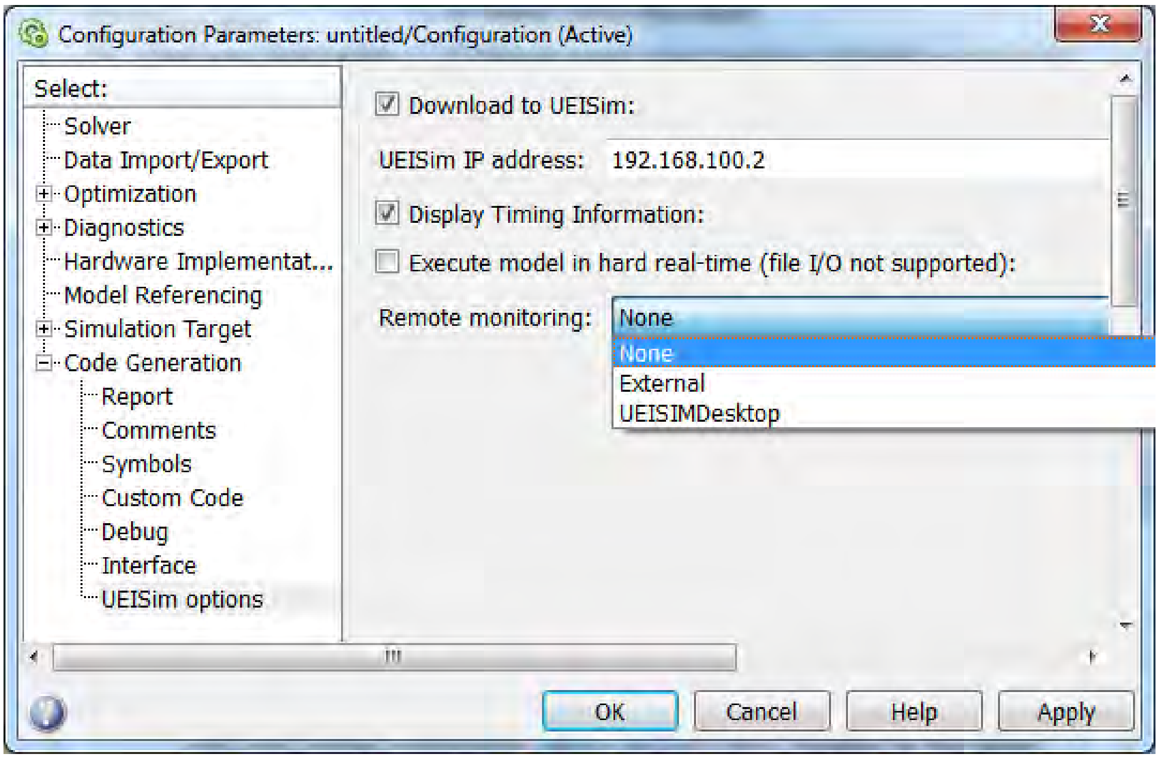



Select **UEISim options**




- **Download to UEISim**: Check this option to automatically download the simulation executable to the UEISim.
- **UEISim IP address**: Enter the IP address of the UEISim.
- **Display Timing Information**: Turn on timing information output. Your model will print timing information once a second while running on the target.
- **Execute model in hard real-time**: when enabled the model is executed in the context of a Xenomai real-time task. When disabled the model is executed in the context of a high priority Linux process. You cannot use any block doing file I/O (such as "To File") in hard real-time mode.
- **Remote monitoring**: Select the type of remote monitoring. 'None': no monitoring, 'External': Use Simulink in external mode, 'UEISIMDesktop': Use UEISIMDesktop protocol (more details in section 3.5)

Click on **Real-Time Workshop** (or on **Code Generation**) again and then on **Build**. This will start the code generation and build process.

You should see an output similar to the following in MATLAB's command window:

```
### Generating code into build directory: C:\test\ueisim_ueipac_rtw
### Invoking Target Language Compiler on ueisim.rtw
```

```
tlc
-r
C:\test\ueisim.rtw
e:\uei_svn\software\powerdna\3.3.x\UEIPAC\Simulink_rtw\ueisim.tlc
-OC:\test\ueisim_ueipac_rtw
-Ie:\uei_svn\software\powerdna\3.3.x\UEIPAC\Simulink_rtw
-IC:\test\ueisim_ueipac_rtw\tlc
-IC:\Program Files\MATLAB\R2007b\rtw\c\tlc\mw
-IC:\Program Files\MATLAB\R2007b\rtw\c\tlc\lib
-IC:\Program Files\MATLAB\R2007b\rtw\c\tlc\blocks
-IC:\Program Files\MATLAB\R2007b\rtw\c\tlc\fixpt
-IC:\Program Files\MATLAB\R2007b\stateflow\c\tlc
-aEnforceIntegerDowncast=1
-aFoldNonRolledExpr=1
-aInlineInvariantSignals=0
-aInlineParameters=0
-aLocalBlockOutputs=1
-aRollThreshold=5
-aZeroInternalMemoryAtStartup=1
-aZeroExternalMemoryAtStartup=1
-aInitFltsAndDblsToZero=1
-aGenerateReport=0
-aGenCodeOnly=0
-aRTWVerbose=1
-aIncludeHyperlinkInReport=0
-aLaunchReport=0
-aGenerateTraceInfo=0
-aForceParamTrailComments=0
-aGenerateComments=1
-aIgnoreCustomStorageClasses=1
-aIncHierarchyInIds=0
-aMaxRTWIdLen=31
-aShowEliminatedStatements=0
-aIncDataTypeInIds=0
-aInsertBlockDesc=0
-aSimulinkBlockComments=1
-aInlinedPrmAccess="Literals"
-aTargetFcnLib="ansi_tfl_table_tmw.mat"
-aIsPILTarget=0
-aLogVarNameModifier="rt_"
-aGenerateFullHeader=1
-aExtMode=0
-aExtModeStaticAlloc=0
-aExtModeTesting=0
-aExtModeStaticAllocSize=1000000
-aExtModeTransport=0
-aRTWCAPISignals=0
-aRTWCAPIParams=0
-aGenerateASAP2=0
-aDownloadToUEIPAC=1
```

```
       -aUEIPACIPAddress="192.168.15.200"
       -aGenerateTraceInfo=0
       -p10000


### Loading TLC function libraries

.....
### Initial pass through model to cache user defined code
.
### Caching model source code
.............................
### Writing header file ueisim_types.h
.
### Writing header file ueisim.h
### Writing source file ueisim.c
### Writing header file ueisim_private.h
.
### Writing header file rtmodel.h
### Writing source file ueisim_data.c
### Writing header file rt_nonfinite.h
### Writing source file rt_nonfinite.c
.
### TLC code generation complete.

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
### Evaluating PostCodeGenCommand specified in the model
Adding e:\uei_svn\software\powerdna\3326E1~1.X\UEIPAC\SIMULI~1 to
source and include paths
.
### Processing Template Makefile:
e:\uei_svn\software\powerdna\3.3.x\UEIPAC\Simulink_rtw\ueipac.tmf
### ueisim.mk which is generated from
e:\uei_svn\software\powerdna\3.3.x\UEIPAC\Simulink_rtw\ueipac.tmf is up
to date
### Building ueisim: .\ueisim.bat

<lots of compiler output>

Created executable: ueisim
Downloading ../ueisim to UEIPAC at 192.168.15.200
Downloaded: ueisim
>>
```

The simulation executable is now ready to be executed in the /tmp directory on the UEISim.

### 4.4. Running the simulation

#### 4.4.1. From the command line

Log on the UEISim using the serial port console, Telnet or SSH and run the simulation executable in the **/tmp** folder:

```
/tmp # ./ueisim
StepSize: 0.010000 s
Model: 201 Option: 100
Model: 308 Option: 1
Model: 207 Option: 1
Model: 205 Option: 1
Model: 404 Option: 1

** starting the model **
```

#### 4.4.2. Using the UEISIM desktop API

UEISim Software comes with an API to remotely control the simulation. The API can be used from C, C++, C# or VB.NET.

The UEISIM desktop API can start/stop a simulation, read signal and parameter values as well as timing statistics. It can also write tunable parameter values.

The API is documented in more details in the manual **UEISIM Desktop User Manual**.

### 4.5. Tuning step size and sample time

The sample time parameter in the various I/O blocks determines the maximum amount of work your model can perform within one step.

To get an idea of your model "load", you can enable the option "Display Timing Information" in the "UEISIm Options" configuration panel.

The model will display timing information once a second while running:

```
**May run forever. Model stop time set to infinity.**

Step completed its work in 0.000085 s, remains 0.000915 s
Min. TET=0.000083, max. TET=0.000148, avg. TET=0.000085
Simulated time 1.000000 s, real time 0.999156 s

Step completed its work in 0.000085 s, remains 0.000915 s
Min. TET=0.000082, max. TET=0.000148, avg. TET=0.000085
Simulated time 2.001000 s, real time 2.000157 s

Step completed its work in 0.000091 s, remains 0.000909 s
```

```
Min. TET=0.000082, max. TET=0.000148, avg. TET=0.000085
Simulated time 3.002000 s, real time 3.001146 s

Step completed its work in 0.000085 s, remains 0.000915 s
Min. TET=0.000082, max. TET=0.000148, avg. TET=0.000085
Simulated time 4.003000 s, real time 4.002159 s
^C
Executed 4047 iterations in 4.047741 s (999.816935 updates per sec.)
```

In the output above, the model is running at 1kHz, each step is taking 85us to do its work out of an allocated 1000us.

The TET values are minimum, maximum and average **task execution time**.

**Simulated time** is the expected simulation time. **Real time** is the measured simulation time while running on the target.

If **real time** exceeds **simulated time**, you are doing too much work in your model. The CPU can't execute the task within the allocated time.

## 4.6. Remote monitoring

### 4.6.1. Remote monitoring with UEISIM desktop

UEISIM desktop protocol allows you to remotely monitor a simulation running on the UEISim. You can monitor the simulation using a generic application, a web browser or a custom application developed in C/C++, C# or VB.NET.

Select the menu option **Simulation/Configuration Parameters**….

Click on the **option Code Generation** then on **UEISim options**.

Verify that the UEISIM IP address is correct

Change the Remote monitoring setting to **UEISimDesktop**.

Click on OK and re-build the model.

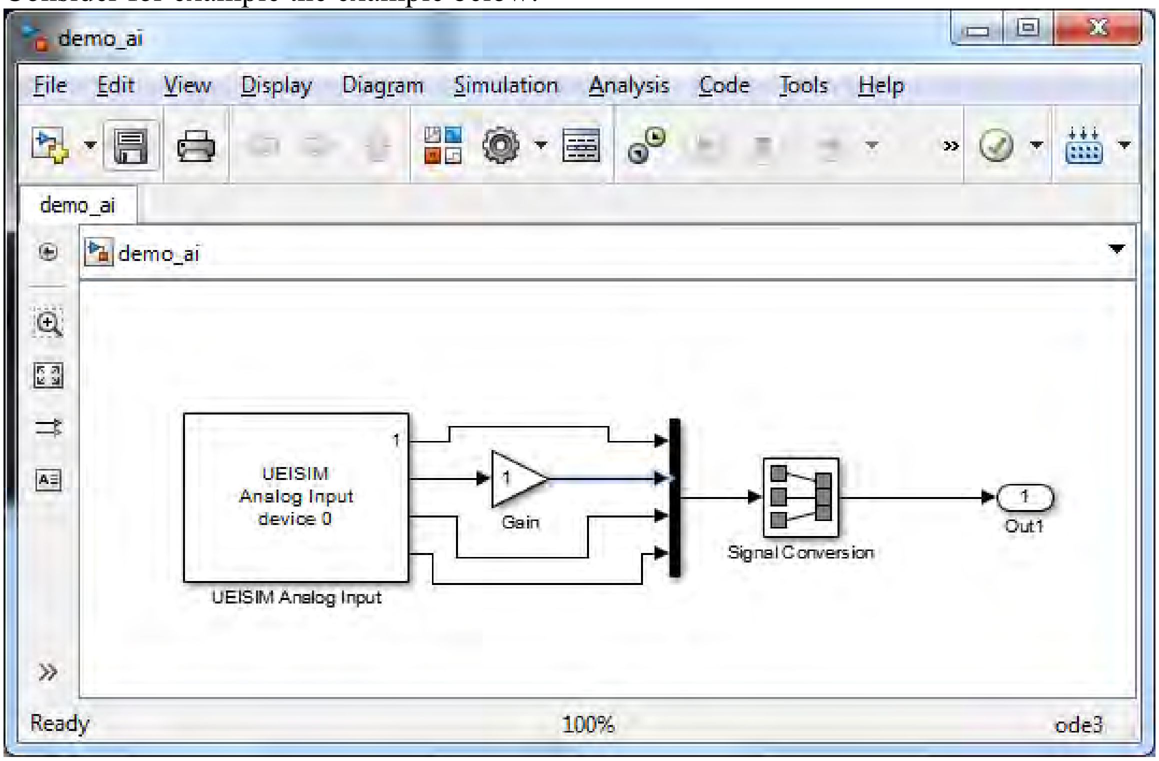
Logon the UEISim and start the simulation. UEISimDesktop protocol uses the TCP/IP port 2345 by default. You can change the port with the command line option '-port'.

```
/tmp # ./ueisim -port 1234
```

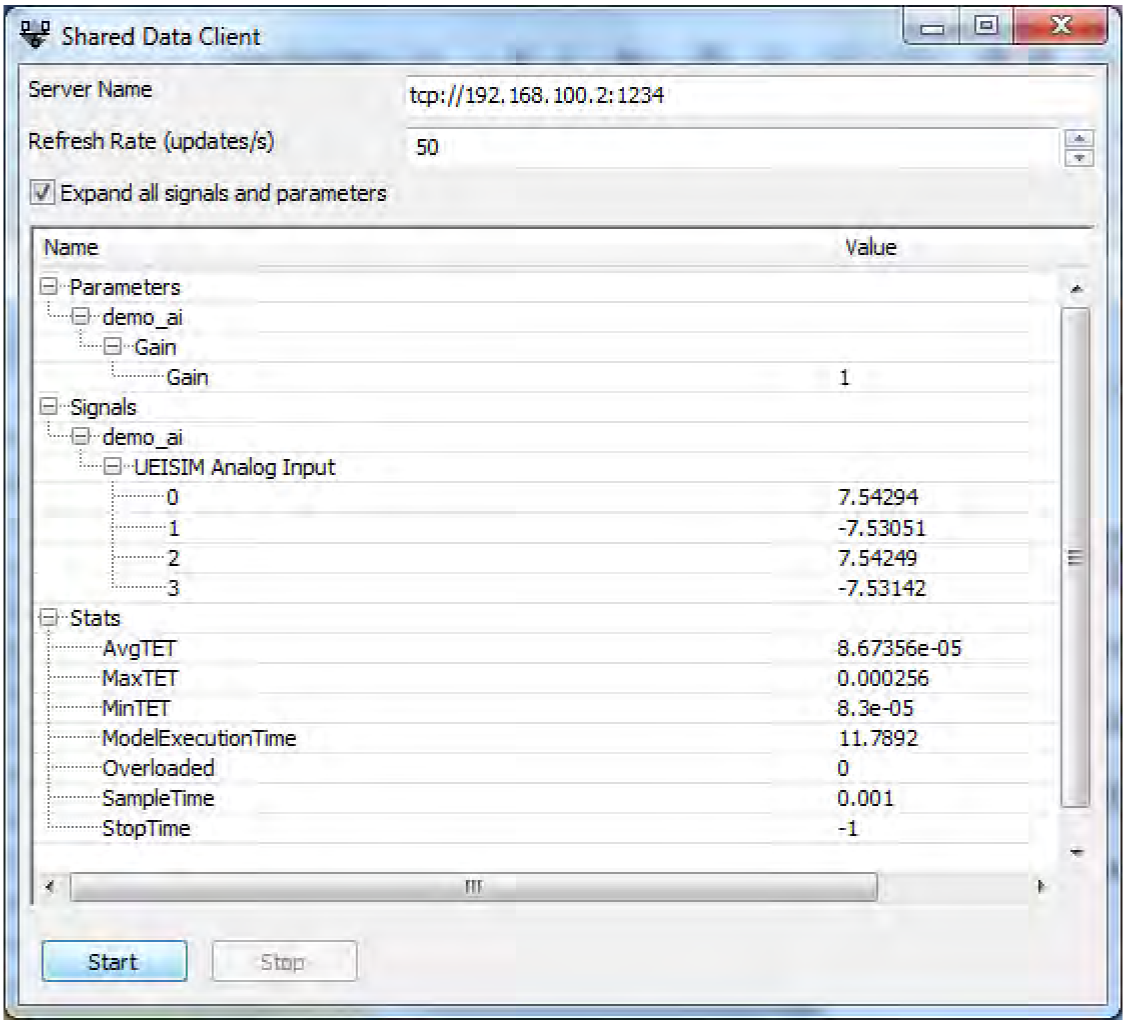
You can now run the generic client (or a client you built using the UEISIM target API)

Use the following URL in the generic client “tcp://192.168.100.2:1234”

Consider for example the example below:




Here is what this model signals and parameters look like in the generic client:




The signals available are the 4 outputs of **UEISIM Analog Input**.

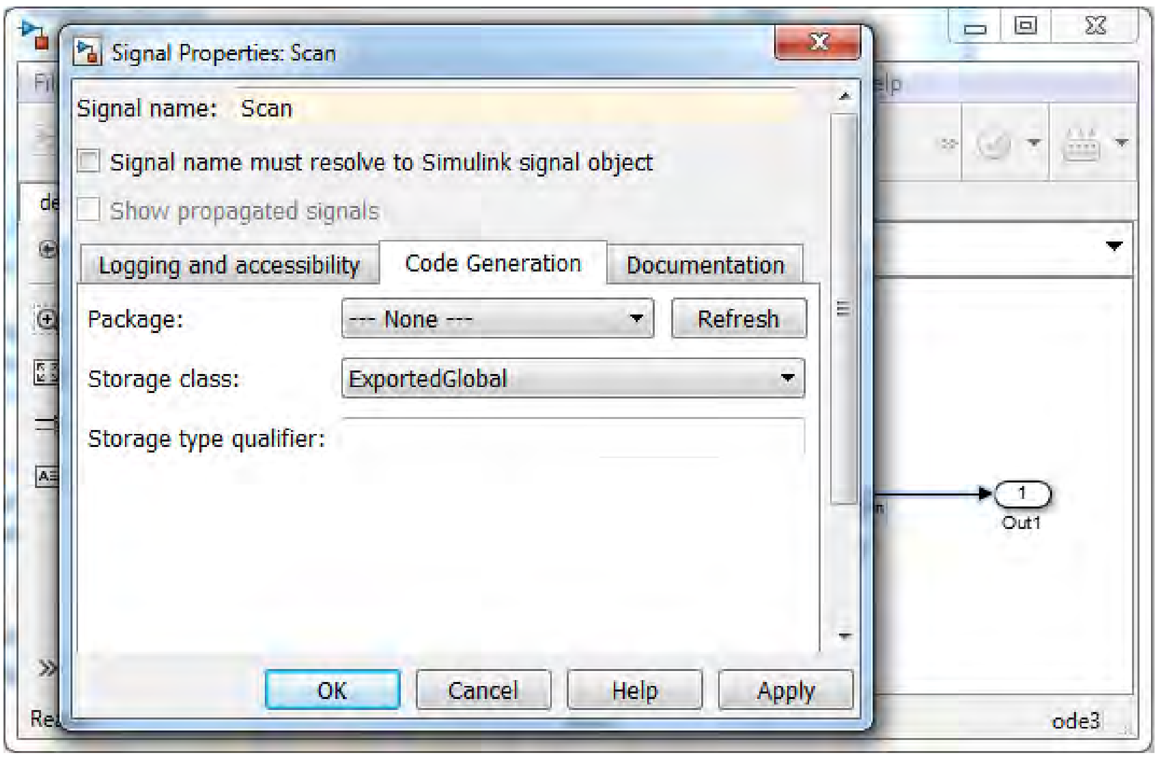
The only tunable parameter is the **Gain** parameter of the **Gain** block (You can not change any of the UEISIM block parameters during simulation)

The UEISIM desktop protocol also makes timing statistics available:

- AvgTET: average task execution in seconds
- MaxTET: maximum task execution time in seconds
- MinTET: minimum task execution time in seconds
- ModelExecutionTime: Number of seconds since simulation started
- Overloaded: 1 is max task execution time ever becomes greater than the sample time. 0 otherwise

* SampleTime: The simulation base sample time in seconds
* StopTime: The simulation duration in seconds (-1 for inifinite)

Other signals must be exported to be able to monitor them remotely. For example to export the signal out of the **Signal Conversion** block, right-click on the signal wire and select **Properties**




Give the signal a name ("Scan") and click on the **Code Generation** tab. Set **Storage class** to **ExportedGlobal** to export the signal.

After the model is rebuilt and executed the client show the new **Scan** signal (which is a vector of 4 values in this case)

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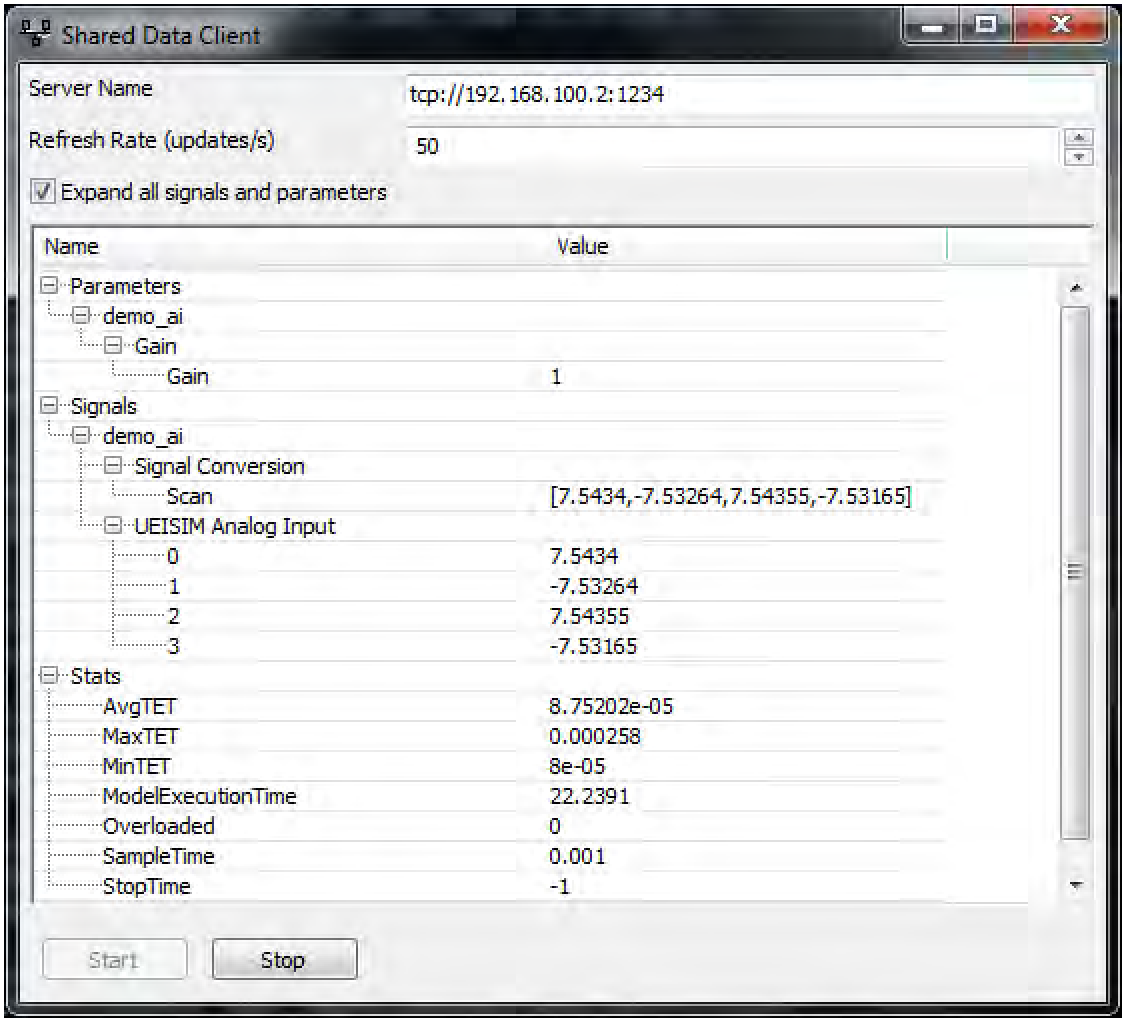
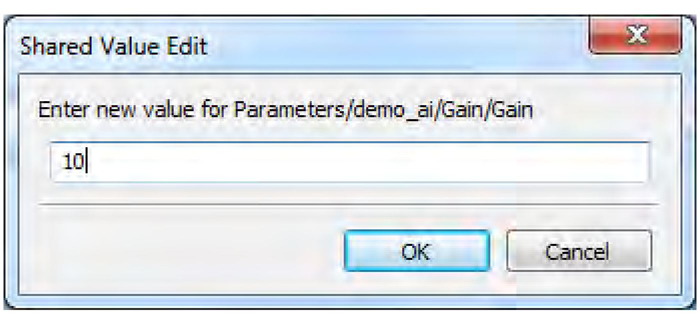



The generic client can change tunable parameters. Double Click on **Gain** and set a new value:



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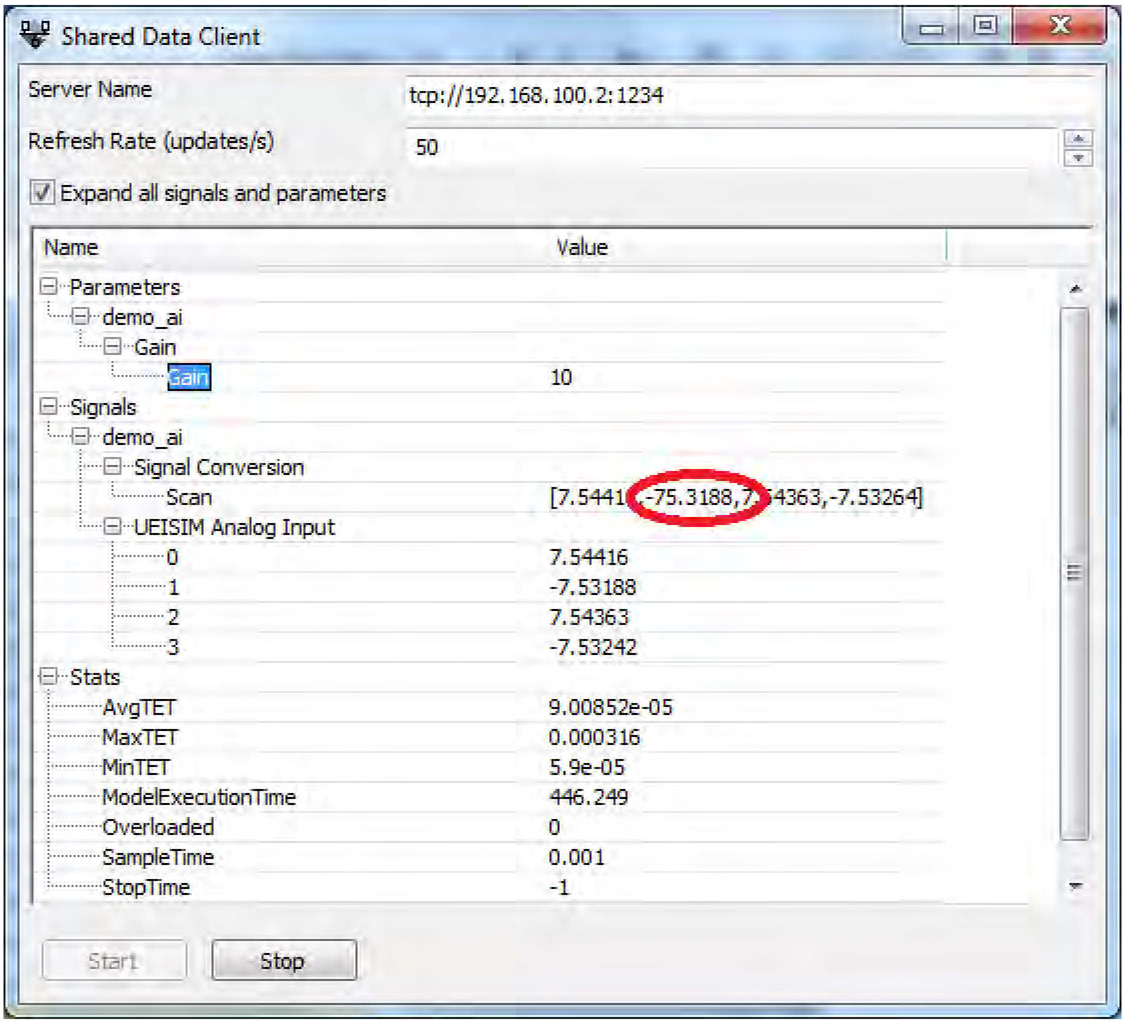
We can immediately see the effect of changing the gain, the second channel out of the **UEISIM Analog Input** block is now multiplied by 10.




The simulation can also be monitored from a web browser. The built-in web server uses the client's port incremented by 1.

For example if you start the simulation with **/tmp/ueisim_demo –p 1234**, you can monitor the parameter and signals from the URL **http://192.168.100.2:1235/ueisim.html**

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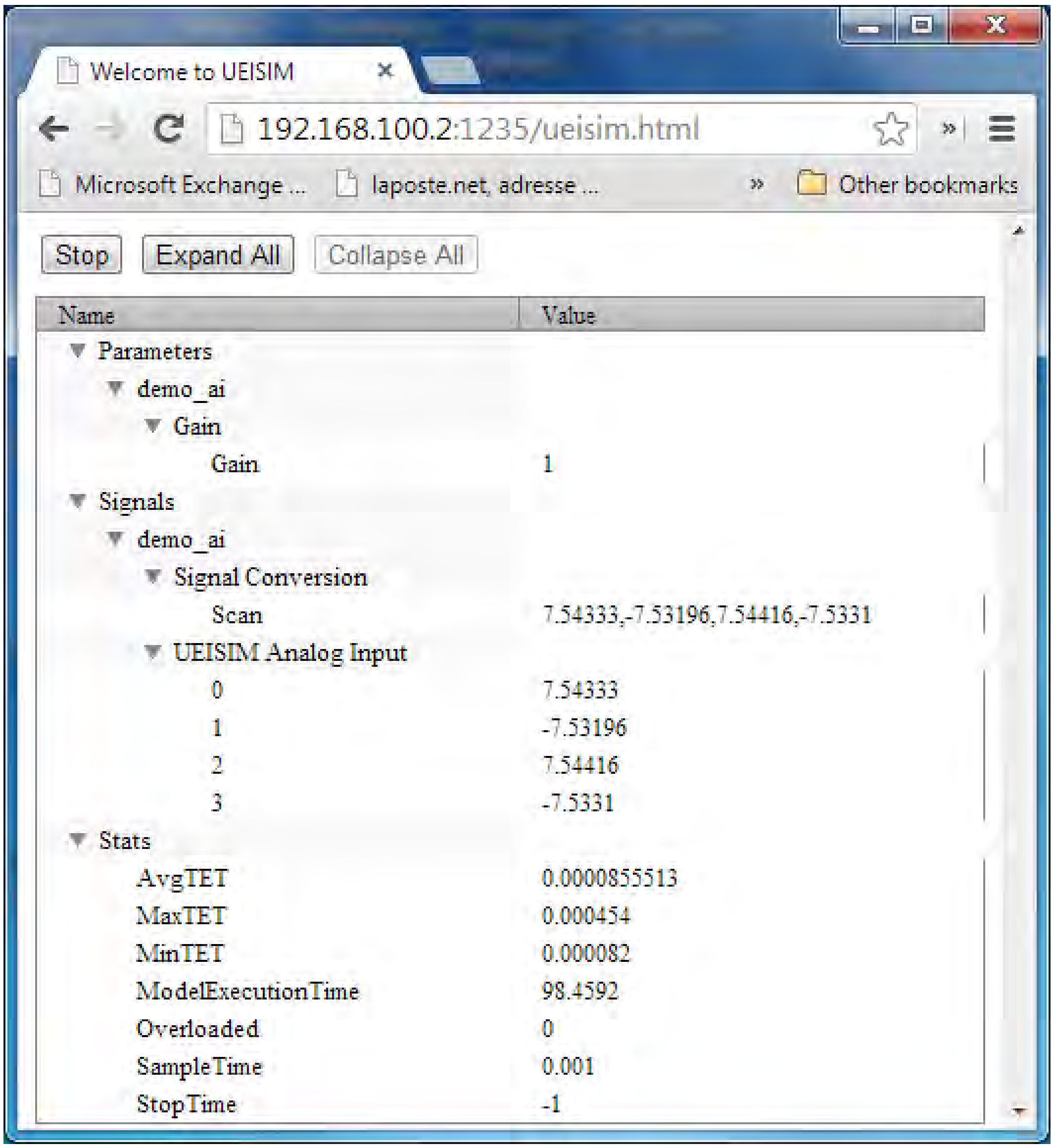



### 4.6.2. Remote monitoring with Simulink in external mode

Simulink's external mode allows you to remotely monitor a simulation running on the UEISim from the Simulink application running on your host OC.

Select the menu option **Simulation/Configuration Parameters…**.

Click on the option **Code Generation** then on **UEISim options**.

Verify that the UEISIM IP address is correct

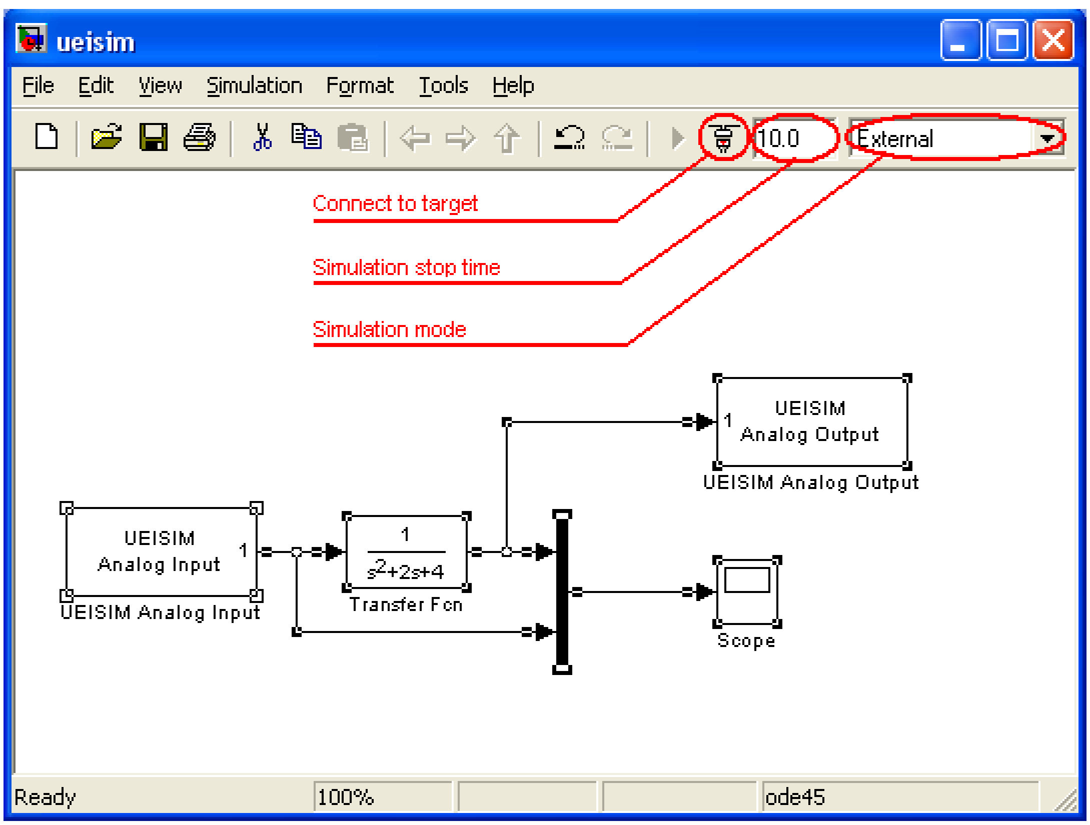
Change the Remote monitoring setting to **External.**

Click on OK and re-build the model.

Logon the UEISim and start the simulation with the command line option '-w'.

```
/tmp # ./ueisim -w
```

This option tells the model to wait for commands received over the network before starting execution.



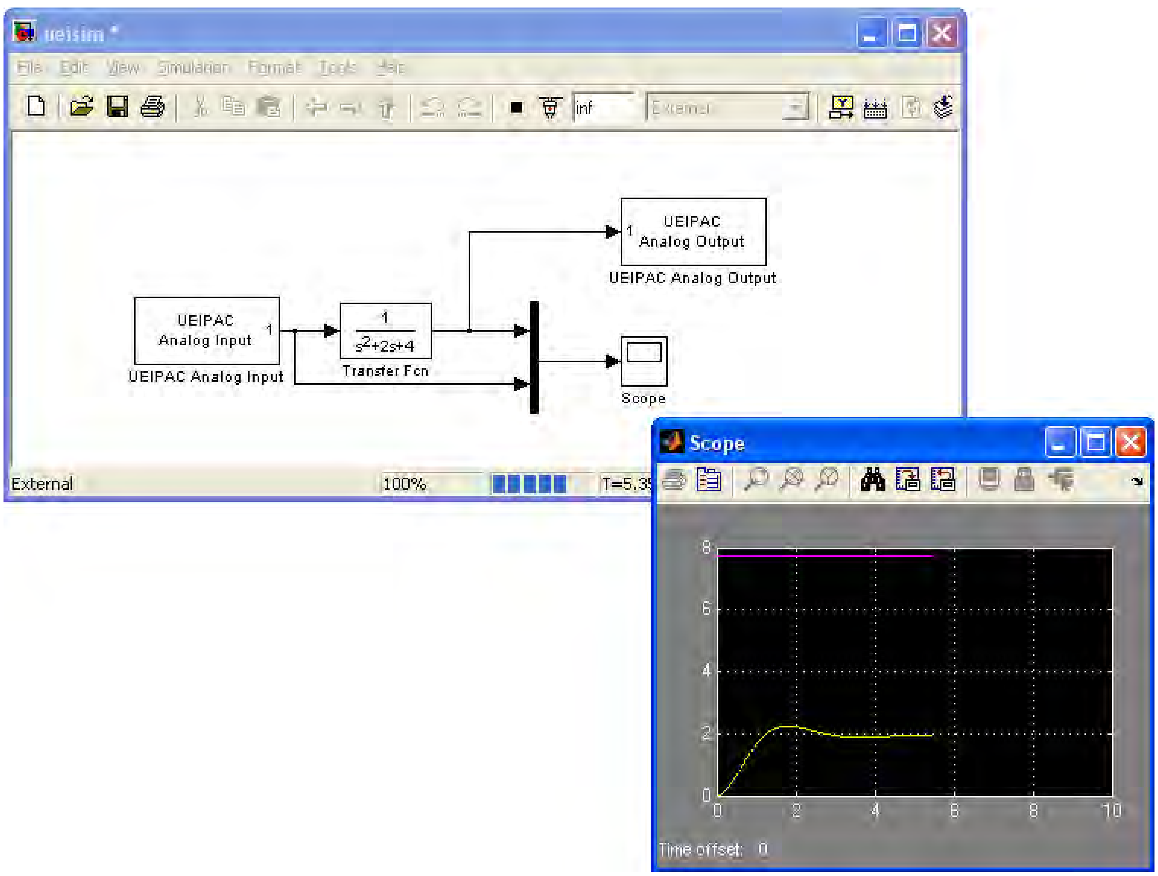

Set the Simulation stop-time to "inf" if you wish to run the simulation continuously.

In your model window, change the **simulation mode** from **normal** to **external** using the toolbar combo-box.

Click on the **Connect to target** button.

After a few seconds, you will be notified that the connection is established when the **Start real-time code** button becomes enabled and the word **External** appears in the status bar.

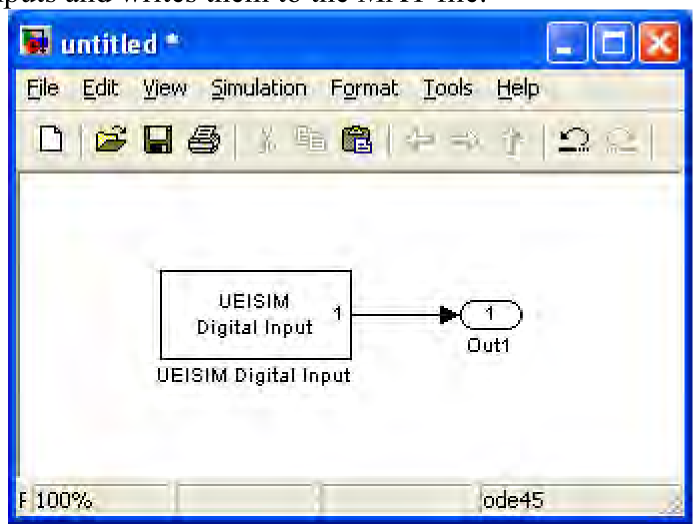
Click on the **Start real-time code** button to start the simulation.
Double-click on the scope to view the acquired signal as well as the result of the transfer function.




## 4.7. Logging Data to file

A Matlab MAT data file is automatically created when the model is executed on the UEISIM. By default it only contains one column of data representing the time of each step.

Use the “Out” block to add a column of data to the MAT file. The example below acquires digital inputs and writes them to the MAT file:

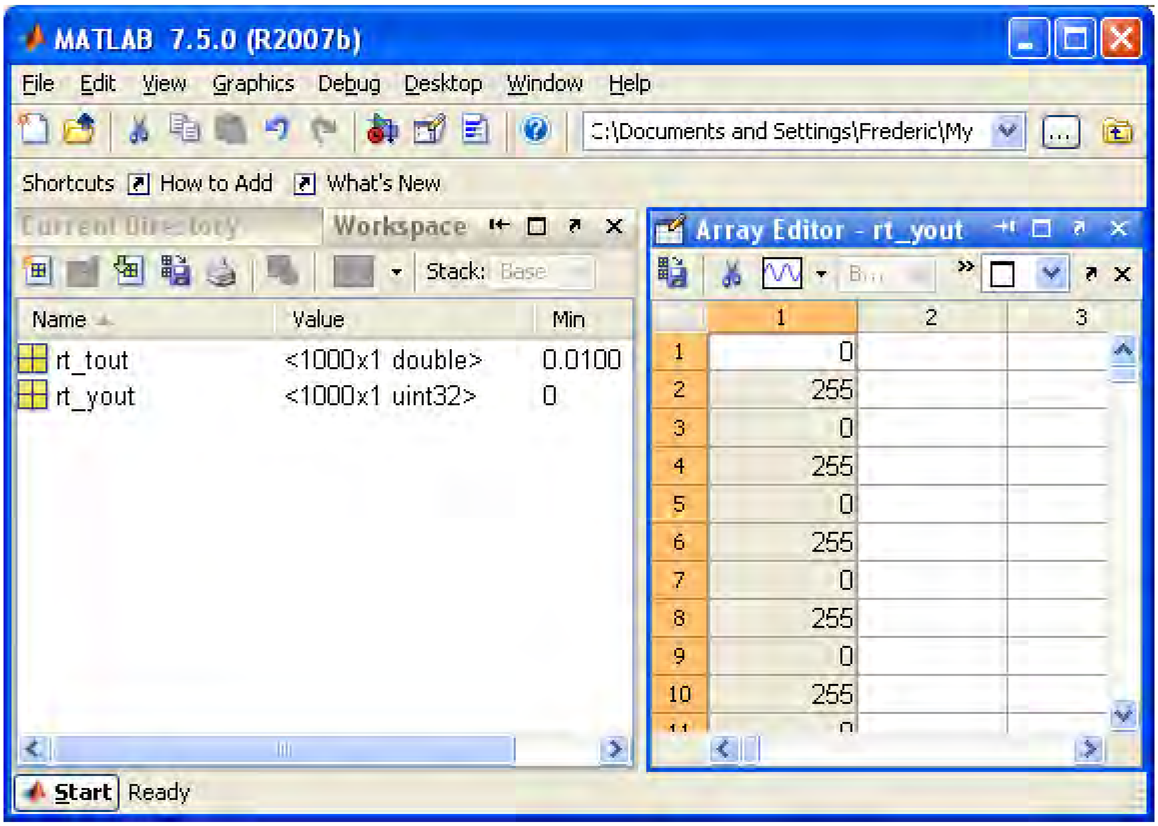



To look at the content of the MAT file, download the file from the UEISIM (using FTP or SCP) and open it with Matlab.

You can download the file directly from Matlab’s command line with the following commands:

```
f=ftp('192.168.100.2','root', 'root')
cd(f,'tmp')
binary(f)
mget(f,'untitled.mat')
```

“rt_tout” is the time of each step
“rt_yout” is the data sent to the Out block.




## 4.8. Running a simulation automatically after boot

Edit the file /etc/rc.local and add an entry for any number of programs that you want to run after the UEISIM complete its power-up sequence.
In the example below, the /etc/rc.local file is modified to run the program “ueisim” at boot time.

```
#!/bin/sh
#
# rc.local
#
# This script is executed at the end of the boot sequence.
# Make sure that the script will "exit 0" on success or any other
# value on error.
#

listlayers > /etc/layers.xml
sync
devtbl
```

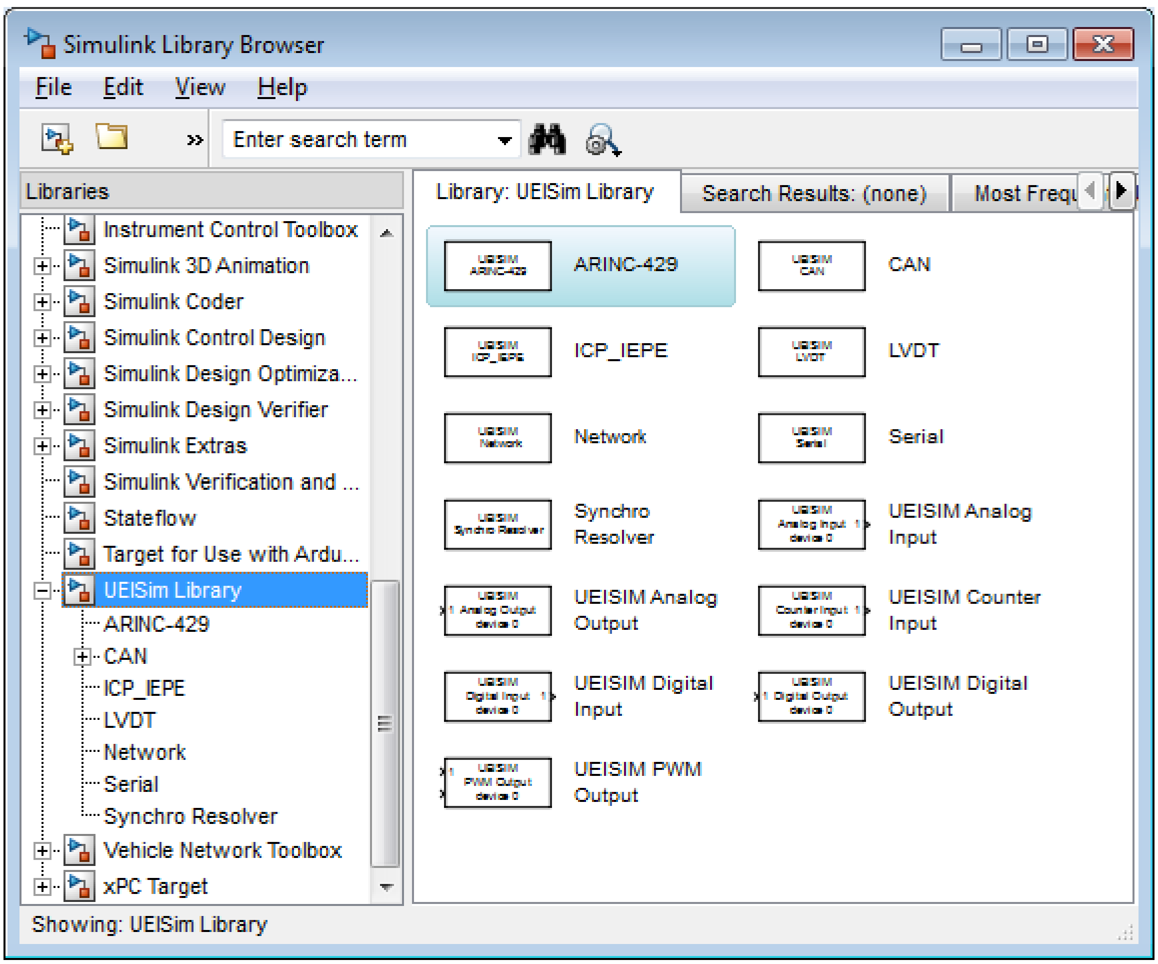
```
# start Sample201
/tmp/ueisim &

exit 0
```

Note that “ueisim” is executed in the background (‘&’ prefix). To stop “ueisim” you must send the SIGINT signal with the following command (It is equivalent to typing CTRL+C on the console if “ueisim” was running in the foreground):

```
killall -SIGINT ueisim
```

# 5. UEISIM Blockset



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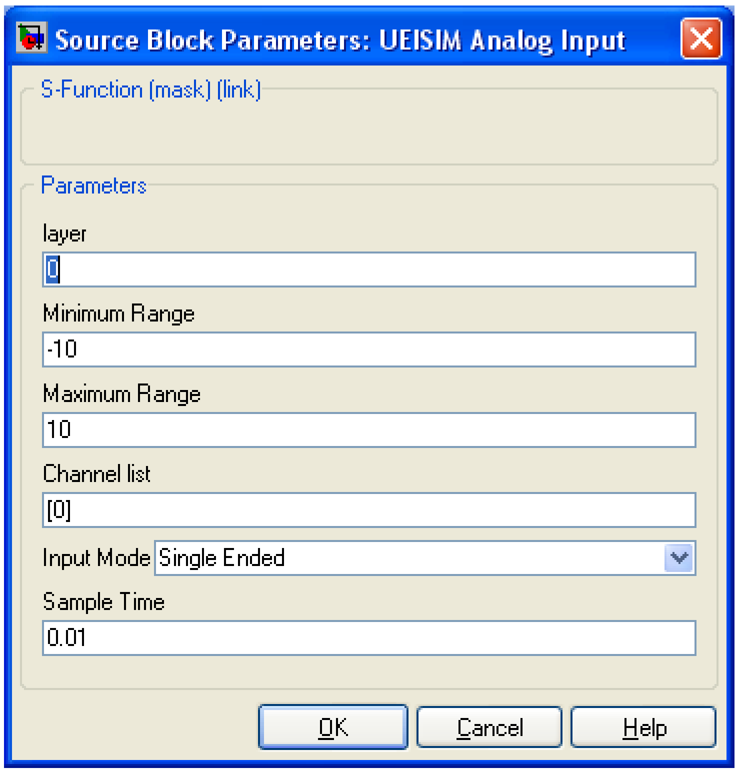
## 5.1. Analog Input block

The Analog Input block acquires data from the channels specified in the channel list. Each channel measurement is available as a separate output.
The data type is double; unit is volts.

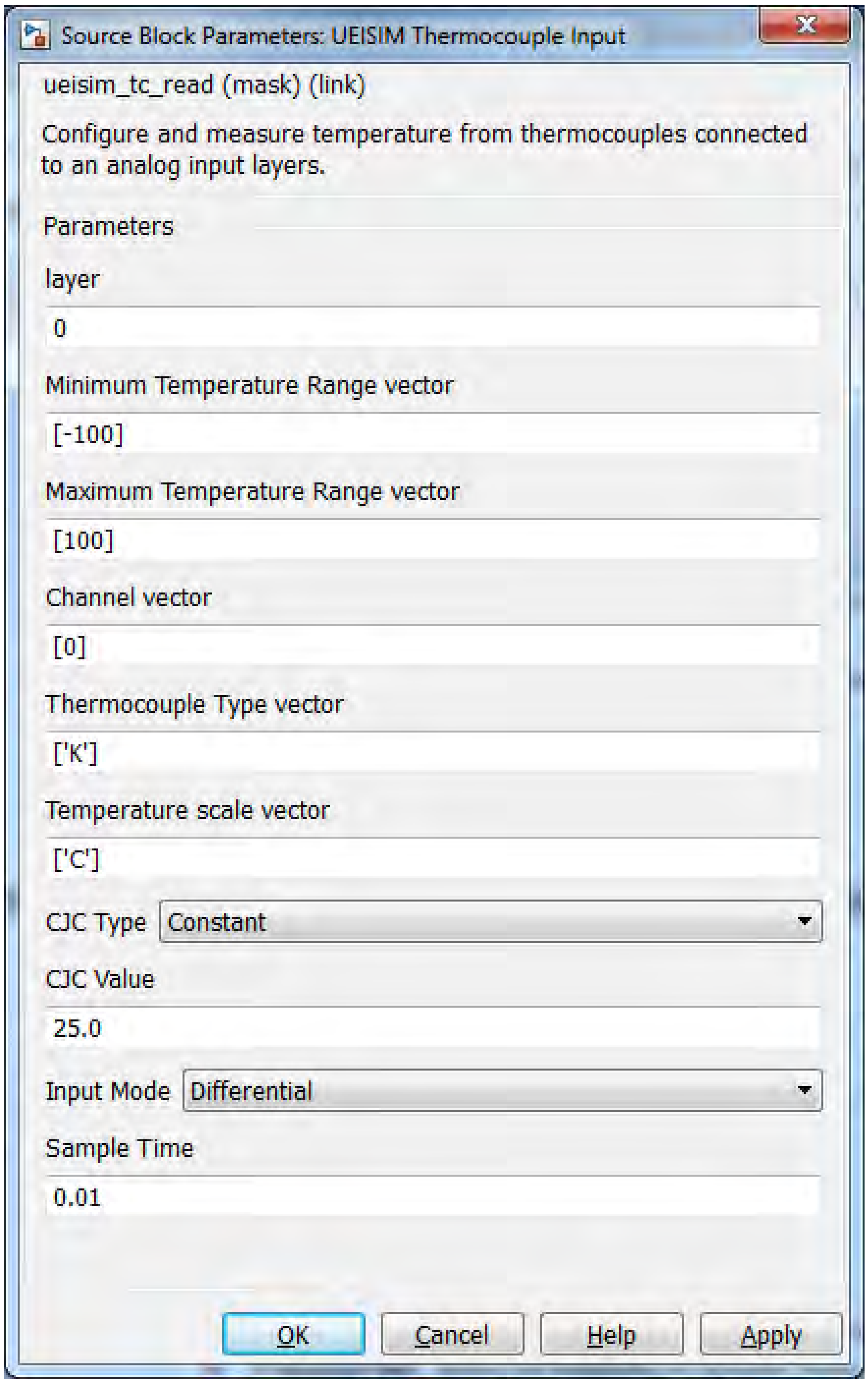



- **layer**: The Id of the analog input layer associated with this block. (layer Ids start at 0 with the top layer)
- **Minimum Range**: The minimum voltage expected at the input
- **Maximum Range**: The maximum voltage expected at the input
- **Channel list**: Array of channels to acquire from
- **Input Mode**: Single Ended or Differential
- **Sample Time**: The rate at which the block executes during simulation (it also sets the hardware ADC clock).

## 5.2. Thermocouple Input block

The Thermocouple Input block acquires data from the channels specified in the channel list. Each temperature measurement is available as a separate output.

The data type is double; unit is same as the temperature scale specified in the block parameters.



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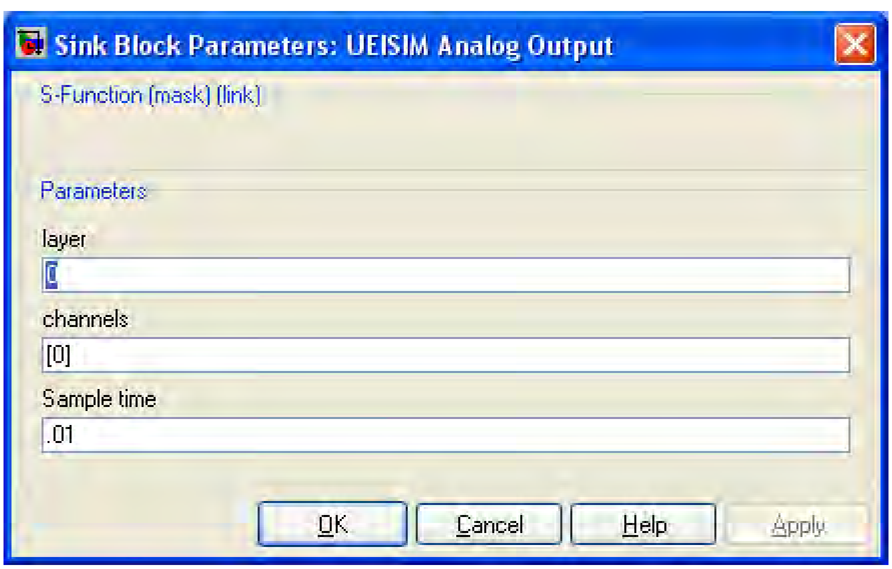
- **layer**: The Id of the analog input layer associated with this block. (layer Ids start at 0 with the top layer)
- **Minimum Range**: The minimum temperature expected at the input
- **Maximum Range**: The maximum temperature expected at the input
- **Channel list**: Array of channels to acquire from
- **Thermocouple type**: The type of thermocouple connected to each channel. Supported types are E, J, K, R, S, T, B, N, C
- **Temperature Scale**: The temperature scale for each channel. ‘C’ for Celsius, ‘F’ for Fahrenheit, ‘K’ for Kelvin and ‘R’ for Rankin.
- **CJC Type**: The type of cold-junction compensation. It can be ‘Built-in’ or ‘Constant’.
- **CJC Value**: The temperature constant used when CJC type is set to ‘Constant’
- **Input Mode**: Single Ended or Differential
- **Sample Time**: The rate at which the block executes during simulation (it also sets the hardware ADC clock).

### 5.3. Analog Output block

The Analog Output block updates the voltage generated by the channels specified in the channel list. Each channel update is specified as a separate input.
The data type is double; unit is volts.




- **layer**: The Id of the analog output layer associated with this block (layer Ids start at 0 with the top layer)

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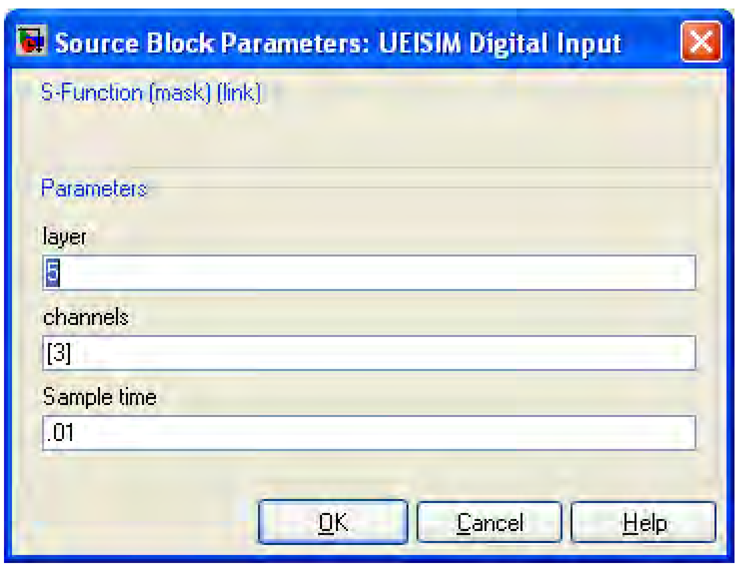
- **Channels**: Array of channels to generate to
- **Sample Time**: The rate at which the block executes during simulation (it also sets the hardware DAC clock).

## 5.4. Digital Input block

The Digital Input block acquires the digital state of the channels specified in the channel list. Each channel is available as a separate output.
A channel is a group of input lines. The number of input lines contained in each channel depends on the hardware (for example the DIO-405 groups its input lines in one port of twelve lines).
The data type is uint32. Each bit of the value read from a given channel corresponds to the state of one input line.

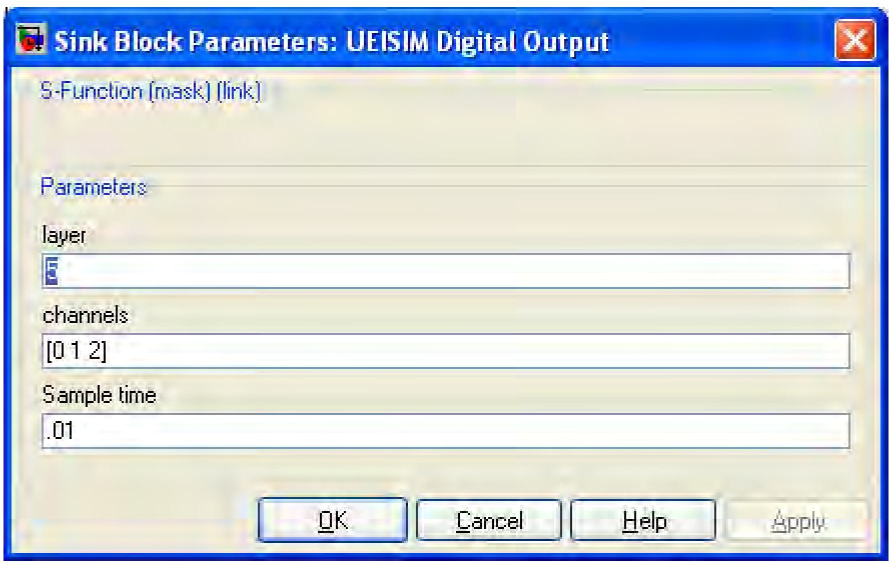



- **layer**: The Id of the digital input layer associated with this block (layer Ids start at 0 with the top layer)
- **Channels**: Array of ports to read from. Input lines are organized into ports (read the manual of your digital layer to find out how many lines there are in each port).
- **Sample Time**: The rate at which the block executes during simulation (it also sets the hardware clock).

## 5.5. Digital Output block

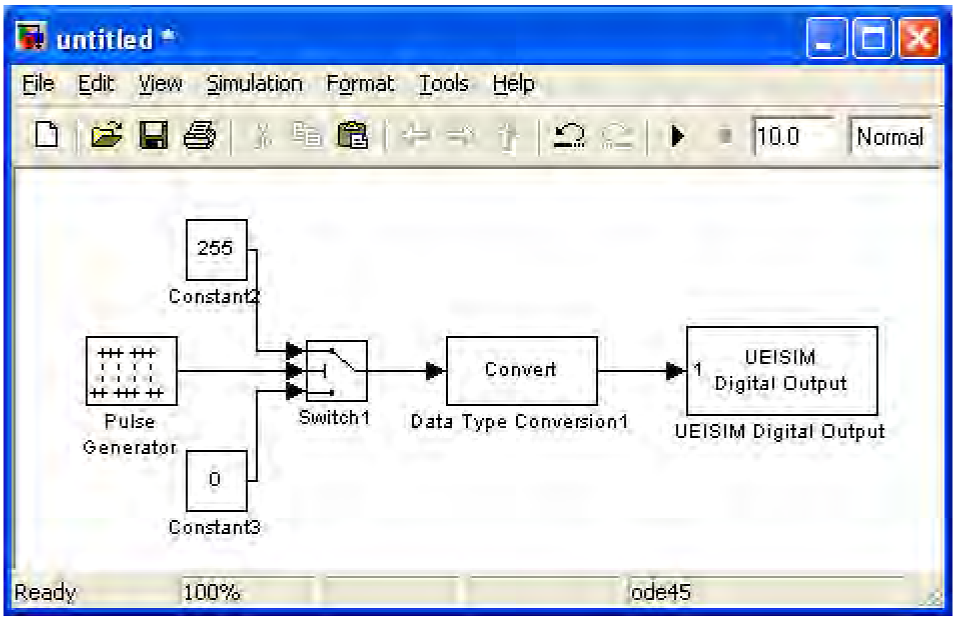
The Digital Output block updates the digital state of the channels specified in the channel list. Each channel is available as a separate input.

A channel is a group of output lines. The number of output lines contained in each channel depends on the hardware (for example the DIO-405 groups its output lines in one port of twelve lines).
The data type is uint32. Each bit of the value written to a given channel corresponds to the state of one output line.




- **layer**: The Id of the digital output layer associated with this block (layer Ids start at 0 with the top layer)
- **Channels**: Array of ports to write to. Input lines are organized into ports (read the manual of your digital layer to find out how many lines there are in each port).
- **Sample Time**: The rate at which the block executes during simulation (it also sets the hardware clock).

The type of the signals connected to the DO block must be “uint32”. You can use Simulink’s “Data Type Conversion block” to convert your signal as shown in the example below:




## 5.6. Counter Input block

The Counter Input block acquires the current count of the specified counter.
Use one instance of this block for each counter you wish to use as input.
The data type is uint32.

The value read depends on the counter operating mode:

- Count Events: Reads the number of rising edges detected on the counter input since the model started
- Pulse Width: The delay between the last rising and falling edges detected on the counter input. Delay is returned in 66MHz clock ticks; divide the value by 66000000.0 to convert to seconds.
- Period: The delay between the two last rising edges detected on the counter input. Delay is returned in 66MHz clock ticks; divide the value by 66000000.0 to convert to seconds.
- Quadrature: Reads the position measured by a quadrature encoder.

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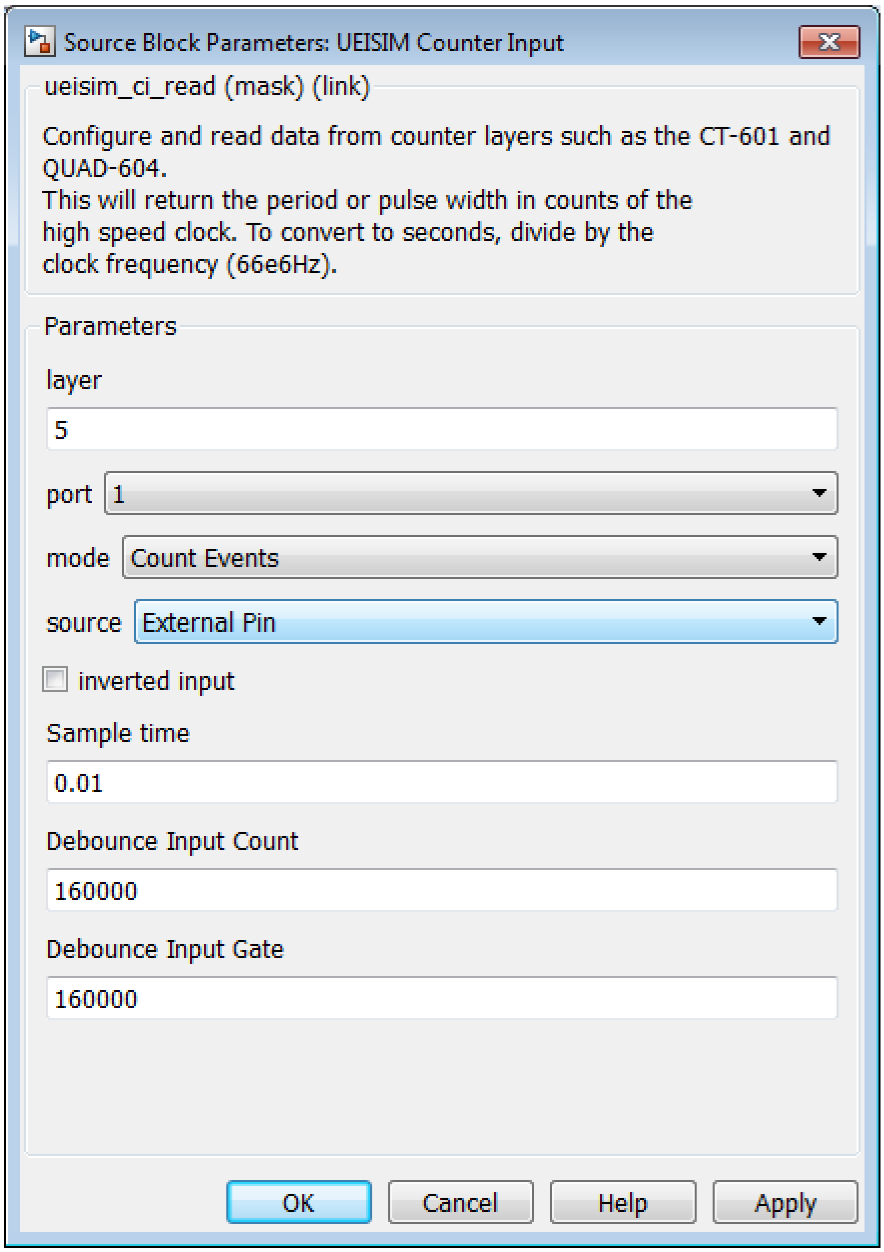


- **layer**: The Id of the digital output layer associated with this block (layer Ids start at 0 with the top layer)
- **port**: The port to read from.
- **mode**: The operation mode. Possible values are "Count Events", "Measure Pulse width", "Measure period" and "Quadrature Encoder".

- **source**: The source of the input signal. Possible values are “Internal Clock” and “External Pin”.
- **inverted input**: the input signal is inverted when this is checked.
- **Sample Time**: The rate at which the block executes during simulation (it also sets the hardware clock).
- **Debounce input count**: the minimum pulse width to accept on counter input. Value is specified in 66Mz ticks. Smaller pulses are rejected.
- **Debounce gate count**: the minimum pulse width to accept on gate input. Value is specified in 66Mz ticks. Smaller pulses are rejected

The type of the signals connected to the CI block must be “uint32”. You can use Simulink’s “Data Type Conversion block” to convert your signal

## 5.7. PWM Output block

The PWM output block generates a continuous train of pulses out of the specified timer. Use one instance of this block for each timer you wish to use as output.
The data type is uint32.

This block contains two inputs: The new low state width (in clock ticks) and the new high state width (in clock ticks) of each pulse.

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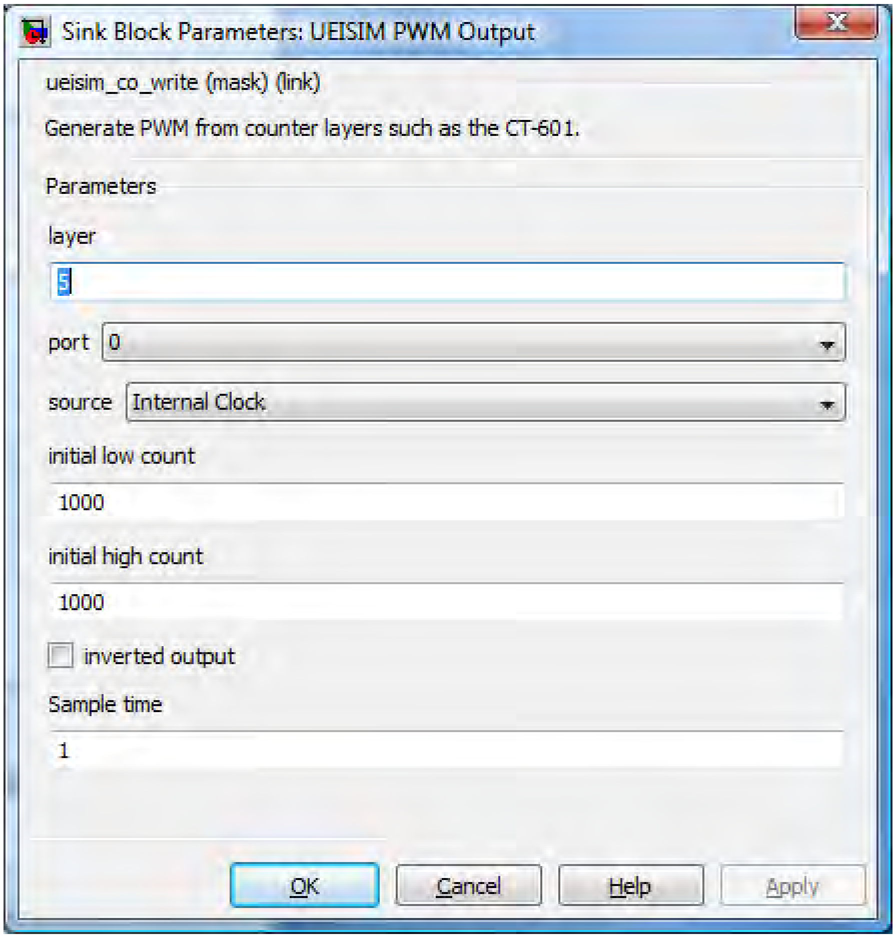


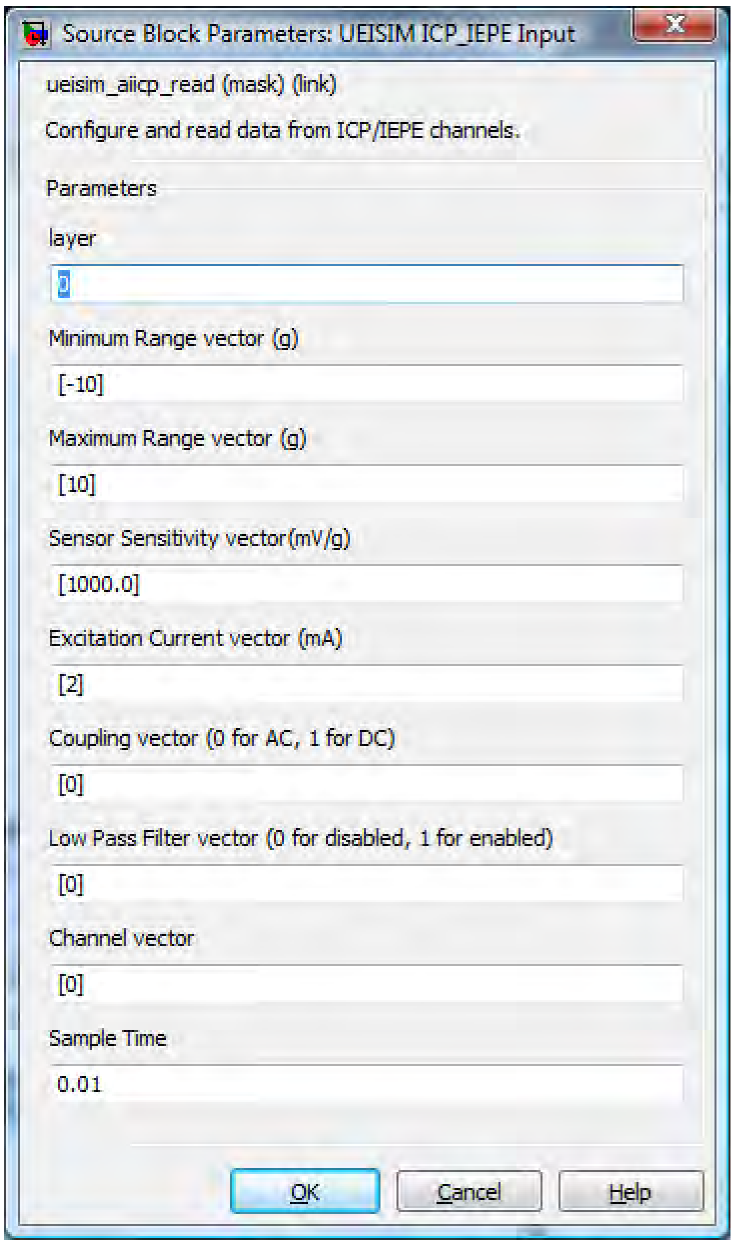

- **layer**: The Id of the digital output layer associated with this block (layer Ids start at 0 with the top layer)
- **port**: The port to read from.
- **source**: The source of the clock signal. Possible values are “Internal Clock” and “External Pin”.
- **initial low count**: The initial width of each pulse low state in clock ticks.
- **initial high count**:The initial width of each pulse high state in clock ticks.
- **inverted output**: the output signal is inverted when this is checked.
- **Sample Time**: The rate at which the block executes during simulation (it also sets the hardware clock).

The type of the signals connected to the CO block must be “uint32”. You can use Simulink’s “Data Type Conversion block” to convert your signal

## 5.8. ICP/IEPE block

Use the ICP/IEPE block to acquire data from ICP or IEPE sensors. Those sensors are only supported by analog input hardware that can provide excitation current to power the sensors (for example the AI-211).

The data type of the value returned for each configured channel is double.



- **layer**: The Id of the analog input layer associated with this block. (layer Ids start at 0 with the top/left layer)
- **Minimum Range vector**: The minimum value expected at the input of each channel
- **Maximum Range vector**: The maximum value expected at the input of each channel
- **Sensor Sensitivity vector**: The sensitivity of the sensor(s) connected to each channel
- **Excitation Current vector**: The excitation current used to power sensor(s) connected to each channel
- **Coupling vector**: The coupling (AC or DC) used on each channel
- **Low Pass Filter vector**: Turns on or off the anti-aliasing low pass filter on each channel
- **Channel vector**: Array of channels to acquire from
- **Sample Time**: The rate at which the block executes during simulation (it also sets the hardware ADC clock).

## 5.9. LVDT

Use the LVDT blocks to acquire data from LVDT sensors and also simulate voltage emitted by real LVDT sensors.
Those sensors are only supported by analog input hardware that can provide excitation current to power the LVDTs (for example the AI-254).

### 5.9.1. LVDT Input block

The data type of the value returned for each configured channel is double.

The unit of the values read by this block is a displacement and depends on the sensor sensitivity unit.

For example, if you specify sensor sensitivity in mV/V/mm, the values read are millimeters.
With sensitivity set to 1000 mV/V/mm you will measure a displacement of -1mm to +1mm when moving the LVDT sensor across its full range.

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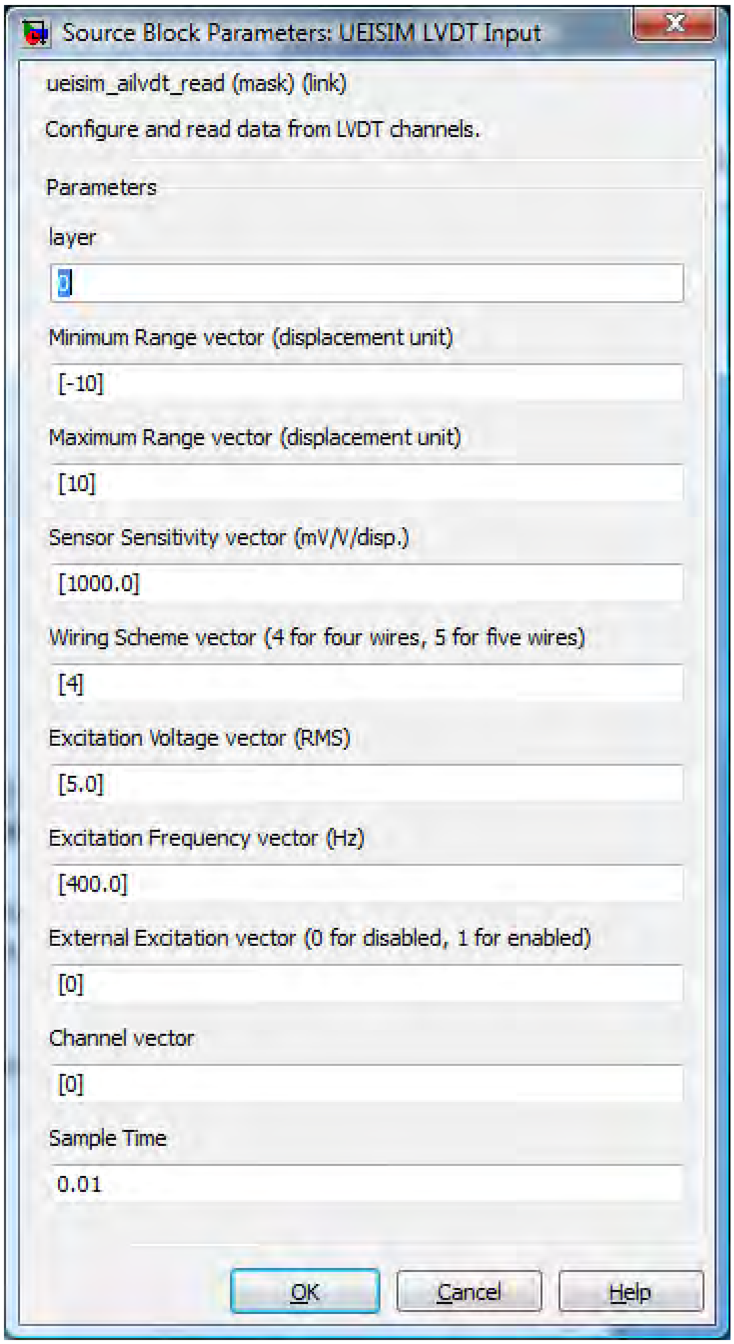



- **layer**: The Id of the analog input layer associated with this block. (layer Ids start at 0 with the top/left layer)

- **Minimum Range vector**: The minimum value expected at the input of each channel
- **Maximum Range vector**: The maximum value expected at the input of each channel
- **Sensor Sensitivity vector**: The sensitivity of the LVDT(s) connected to each channel
- **Wiring Scheme vector**: The wiring scheme (4 or 5 wires) used to connect LVDT(s) to each channel
- **Excitation Voltage vector**: The excitation voltage used to power LVDT(s) connected to each channel
- **Excitation Frequency vector**: The excitation frequency used to power LVDT(s) connected to each channel
- **External Excitation vector**: Specifies whether channel(s) provide excitation to LVDT(s) or whether excitation is supplied externally
- **Channel vector**: Array of channels to acquire from
- **Sample Time**: The rate at which the block executes during simulation (it also sets the hardware ADC clock).

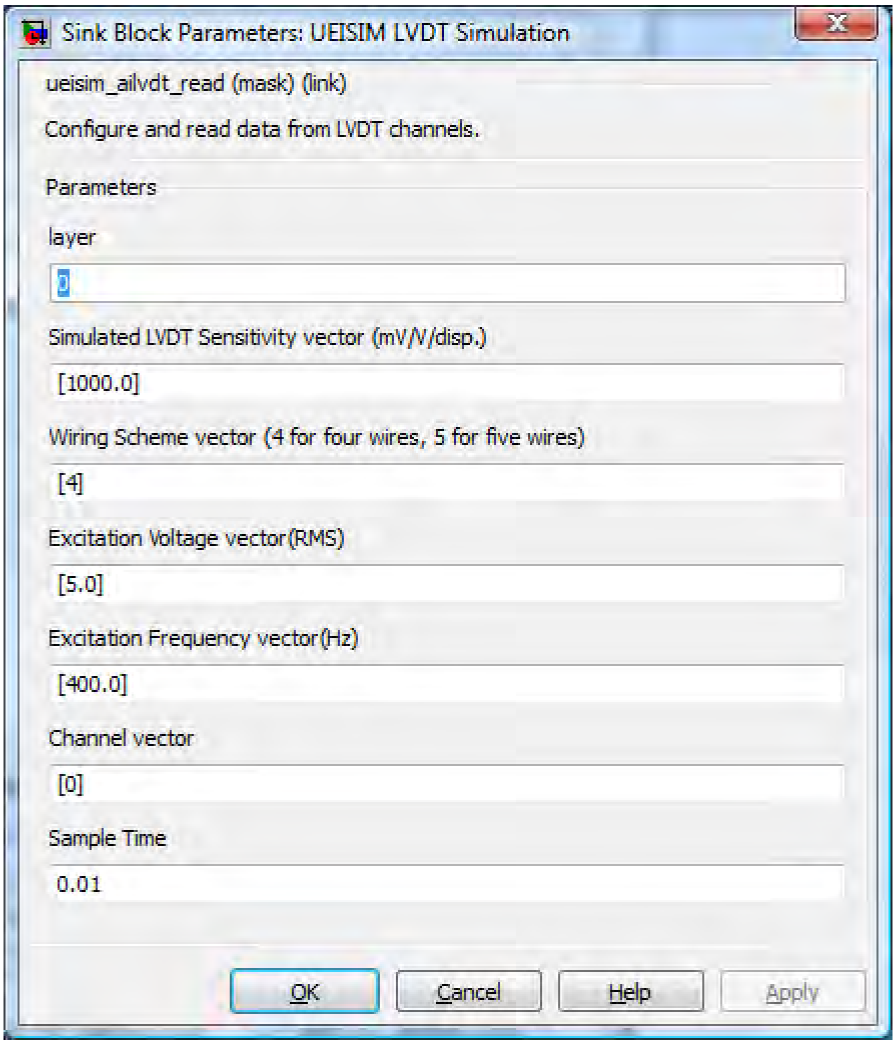
### 5.9.2. LVDT Simulation block

The data type of the value written to each configured channel is double

The unit of the value to simulate is a displacement and depends on the sensor sensitivity unit.

For example, if you set sensor sensitivity in mV/V/mm, the values written to the block must be specified in millimeters.

With sensitivity set to 1000 mV/V/mm, the values written to this block must be in the range [-1,+1] to simulate an LVDT sensor with a full range of -1mm to +1mm.




- **layer**: The Id of the analog input layer associated with this block. (layer Ids start at 0 with the top/left layer)
- **Simulated LVDT Sensitivity vector**: The sensitivity of the LVDT(s) simulated by each channel
- **Wiring Scheme vector**: The wiring scheme (4 or 5 wires) used to connect the LVDT(s) simulated by each channel
- **Excitation Voltage vector**: The excitation voltage used to power LVDT(s) simulated by each channel
- **Excitation Frequency vector**: The excitation frequency used to power LVDT(s) simulated by each channel
- **Channel vector**: Array of channels to simulate from

- **Sample Time**: The rate at which the block executes.

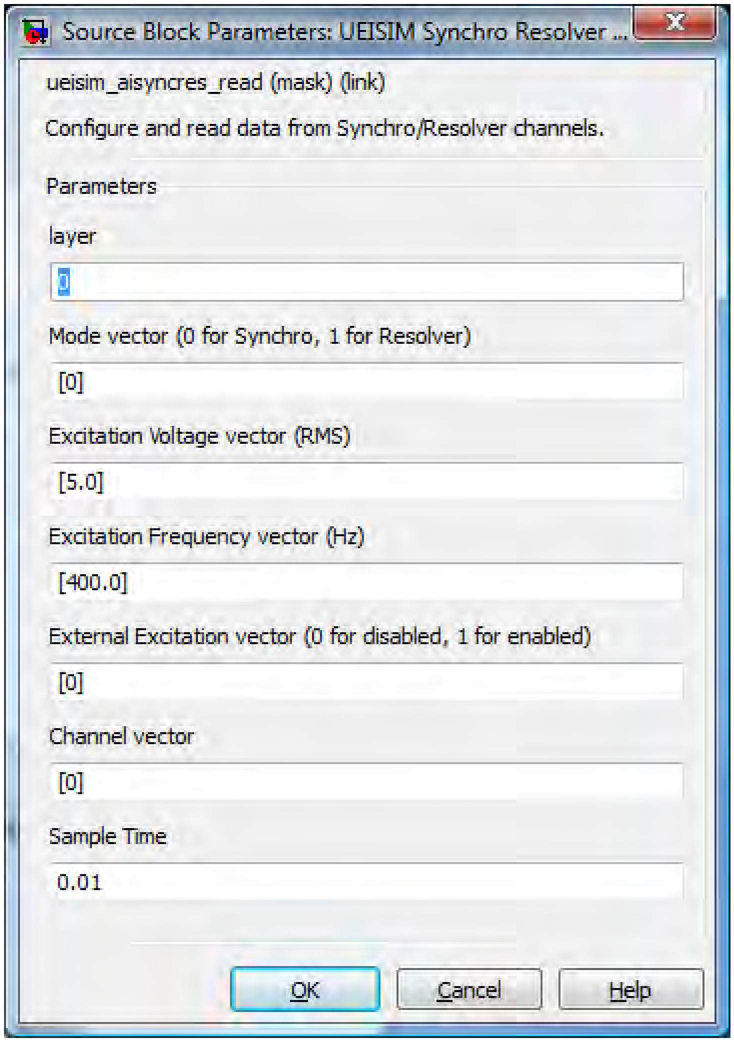
## 5.10. Synchro/Resolver

Use the Synchro/Resolver blocks to acquire data from Synchros or Resolvers and also simulate voltage emitted by real Synchros or Resolvers.
Those sensors are only supported by analog input hardware that can provide excitation current to power the Synchro/Resolvers (for example the AI-255).

### 5.10.1. Synchro/Resolver Input block

The data type of the value returned for each configured channel is double.

Measurements are returned as angles in radian.



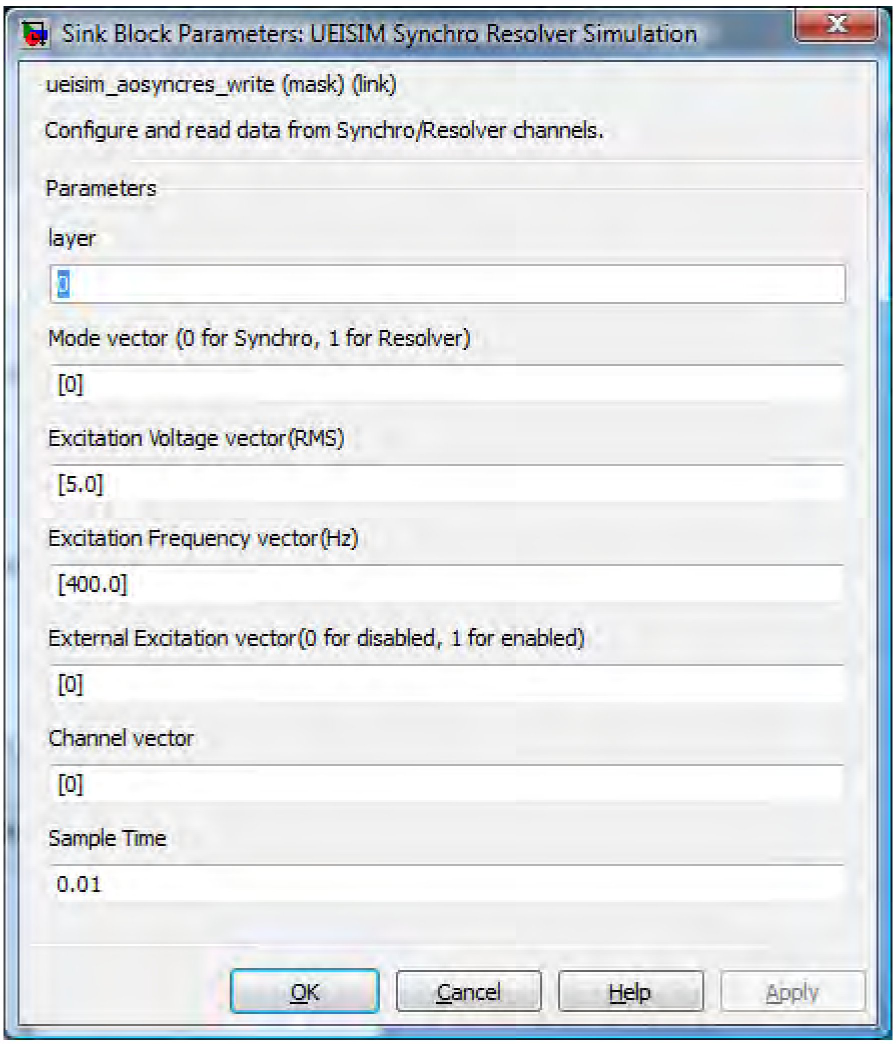

- **layer**: The Id of the analog input layer associated with this block. (layer Ids start at 0 with the top/left layer)
- **Mode vector**: Specifies whether a Synchro or a Resolver is connected to each channel
- **Excitation Voltage vector**: The excitation voltage used to power Synchro/Resolvers(s) connected to each channel
- **Excitation Frequency vector**: The excitation frequency used to power Synchro/Resolver(s) connected to each channel
- **External Excitation vector**: Specifies whether channel(s) provide excitation to Synchro/Resolver(s) or whether excitation is supplied externally
- **Channel vector**: Array of channels to acquire from

- **Sample Time**: The rate at which the block executes during simulation (it also sets the hardware ADC clock).

### 5.10.2. Synchro/Resolver Simulation block

The data type of the value written to each configured channel is double

The value must be specified as an angle in radian.




- **layer**: The Id of the analog input layer associated with this block. (layer Ids start at 0 with the top/left layer)
- **Mode vector**: Specifies whether each channel is simulating a Synchro or a Resolver

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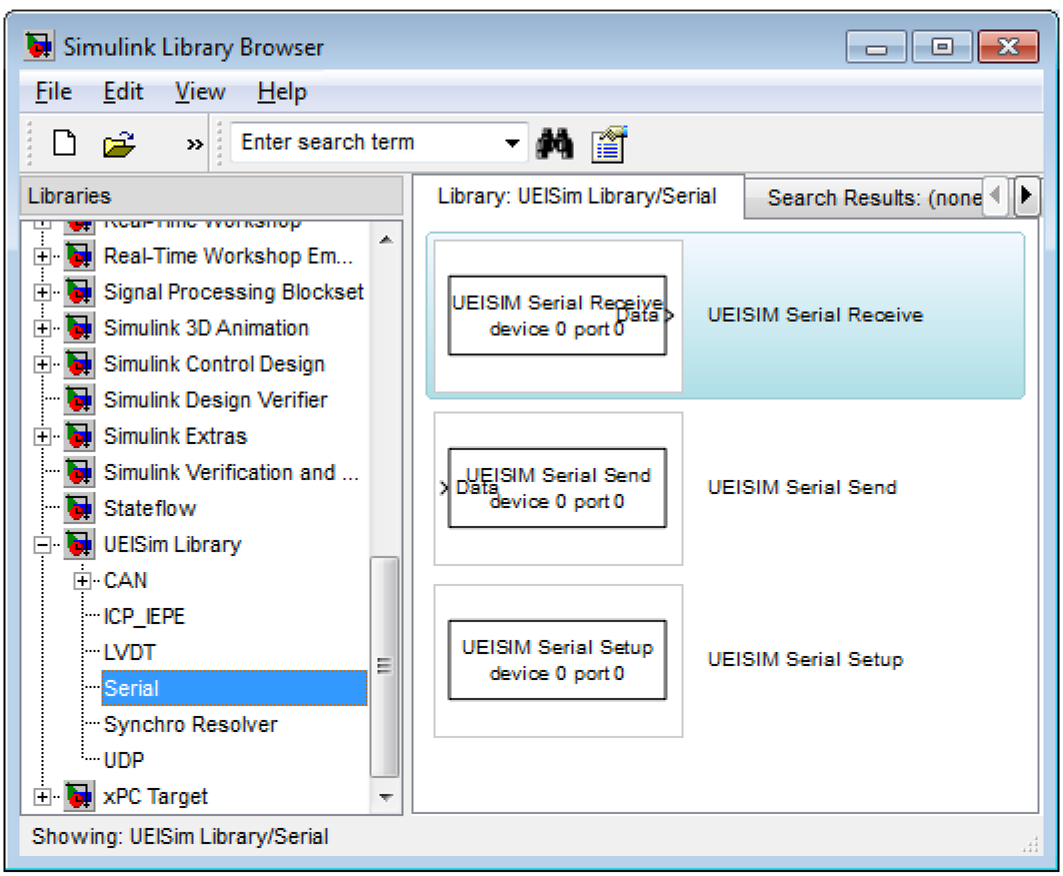
- **Excitation Voltage vector**: The excitation voltage used to power Synchro/Resolver(s) simulated by each channel
- **Excitation Frequency vector**: The excitation frequency used to power Synchro/Resolver(s) simulated by each channel
- **External Excitation vector**: Specifies whether channel(s) provide excitation to Synchro/Resolver(s) or whether excitation is supplied externally
- **Channel vector**: Array of channels to simulate from
- **Sample Time**: The rate at which the block executes

## 5.11. Serial port communication

Serial communication blocks give access to the SL-501 and SL-508 serial ports. The configuration of each port is done using an independent setup block.




Sending and receiving bytes to/from a port is done using a send or receivee block.

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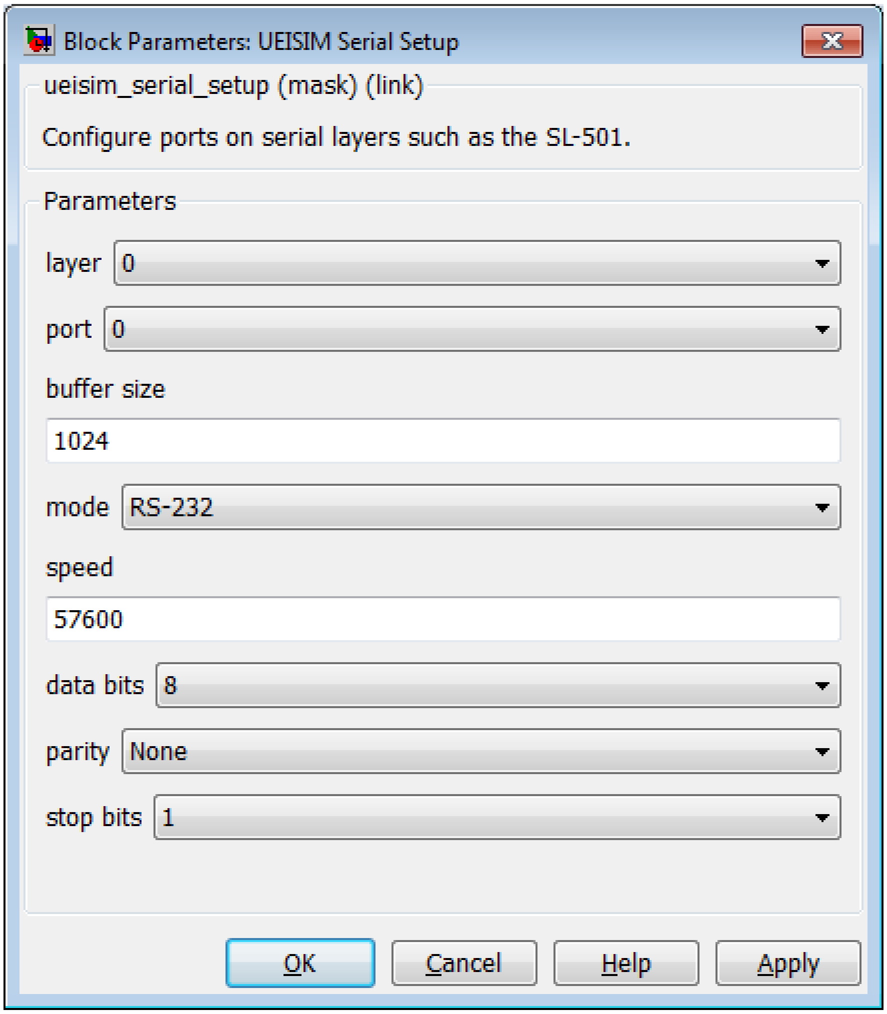
#### 5.11.1. Serial Setup block

Configure communication settings on a given Serial port.

The setup block needs to run before the Send/Receive blocks are called (otherwise an error will be returned during model execution).
To view/change the execution context order: Select the menu option **Format > Block Displays > Sorted Order** and make sure that the setup block has a priority lower than the send and receive block for the same port.
To change a block priority: Right-click the block and select **Block Properties**. On the General tab, in the Priority field, enter the new priority.

There must be one setup block for each serial port used in the model.




- **Layer**: The Id of the Serial layer associated with this block (layer Ids start at 0 with the top layer)
- **Port**: The Id of the port to configure (port Ids start at 0)
- **Buffer size**: Size in bytes of the send/receive buffers (determines the maximum number of bytes able to be received or sent)
- **Mode**: The serial link mode (RS-232/RS-485 HD/RS-485FD)
- **Speed**: The baud rate of the serial link
- **Data bits**: The number of data bits in each transmitted frame
- **Parity**: The method used to calculate the parity bit
- **Stop bits**: The number of stop bits in each transmitted frame

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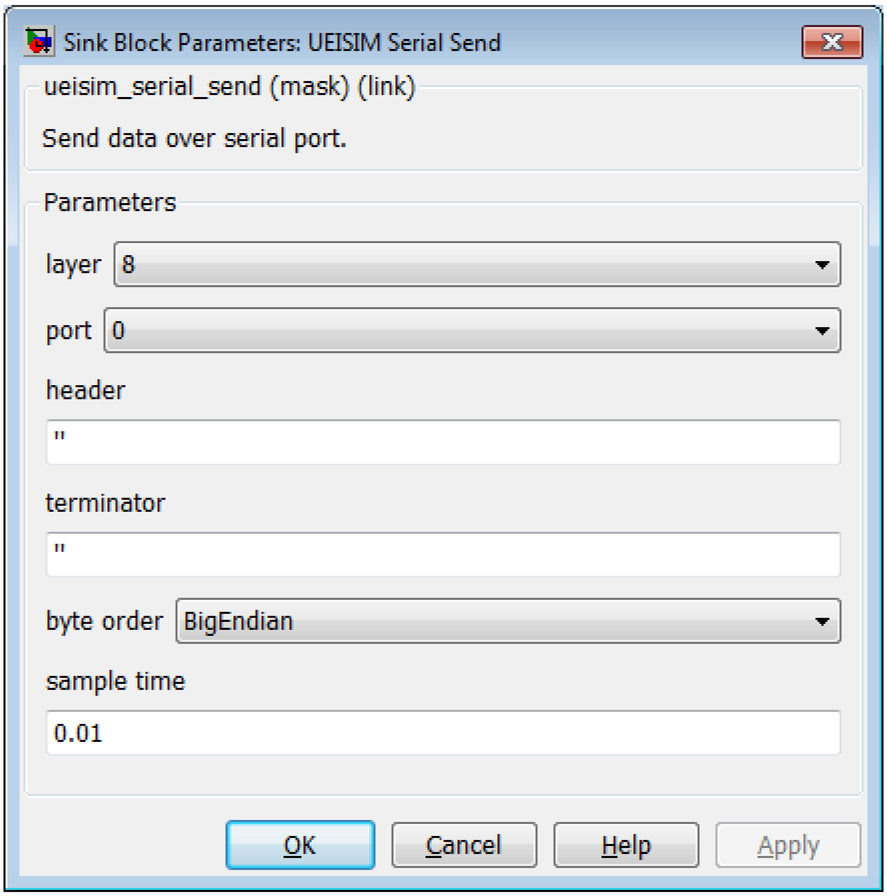
### 5.11.2. Serial Send block

Send a bytes to one Serial port. You can create multiple instance of this block to send data to the same port at different rate.



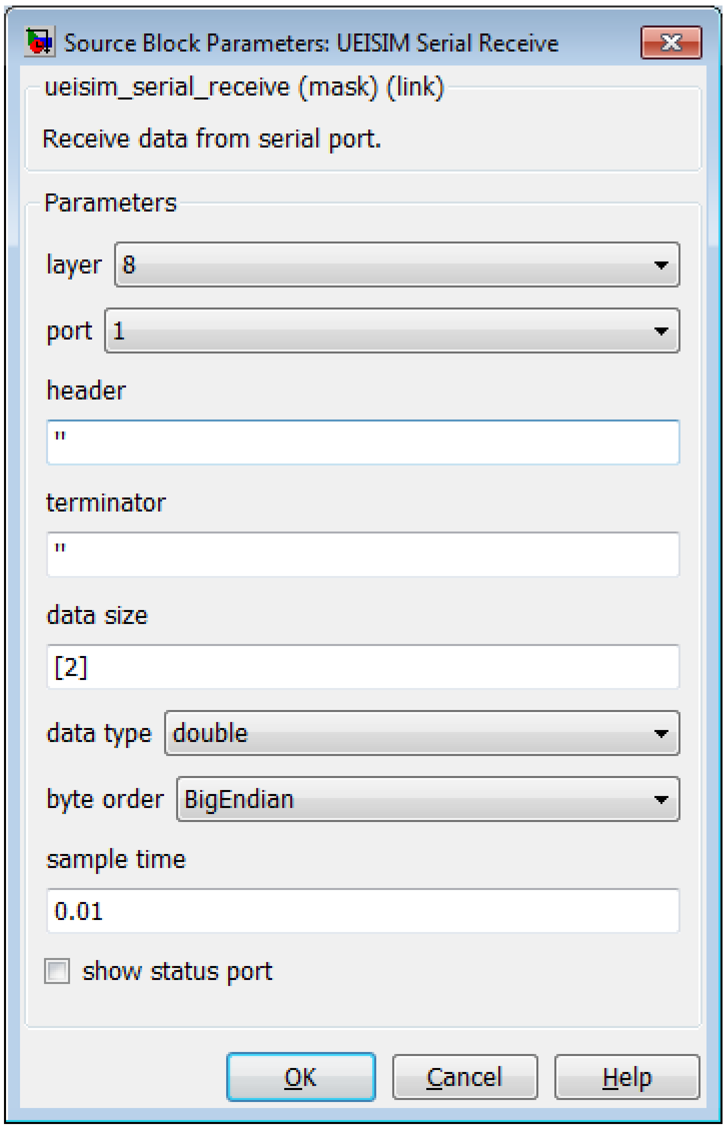

- **Layer**: The Id of the Serial layer associated with this block (layer Ids start at 0 with the top layer)
- **Port**: The Id of the port to send data through (port Ids start at 0)
- **Header**: String of bytes to be sent before the data
- **Terminator**: String of bytes to be sent after the data
- **Byte Order**: The endianness used to convert signal(s) to bytes.
- **Sample Time**: The rate at which the block executes during simulation

The block displays an input port for connecting the value to send through the serial port, it automatically adapts to the data type and dimension of the signal connected.

Use the mux block to combine multiple signals that needs to be sent together.

### 5.11.3. Serial Receive block

Receives bytes from a serial port. You can create multiple instance of this block to receive data from different ports.



* **Layer**: The Id of the Serial layer associated with this block (layer Ids start at 0 with the top layer)
* **Port**: The Id of the port to send data through (port Ids start at 0)
* **Header**: String of bytes that signals the beginning of a data frame
* **Terminator:** String of bytes that signals the end of a data frame
* **Data Size**: Dimension and size of the output signal (for ex [2 4] will output received data in a 2x4 matrix)
* **Data Type**: The data type used to decode received data
* **Byte Order**: The endianness used to convert received bytes to signal(s).
* **Sample Time**: The rate at which the block executes during simulation
* **Show Status Port**: Enable/disable status reporting

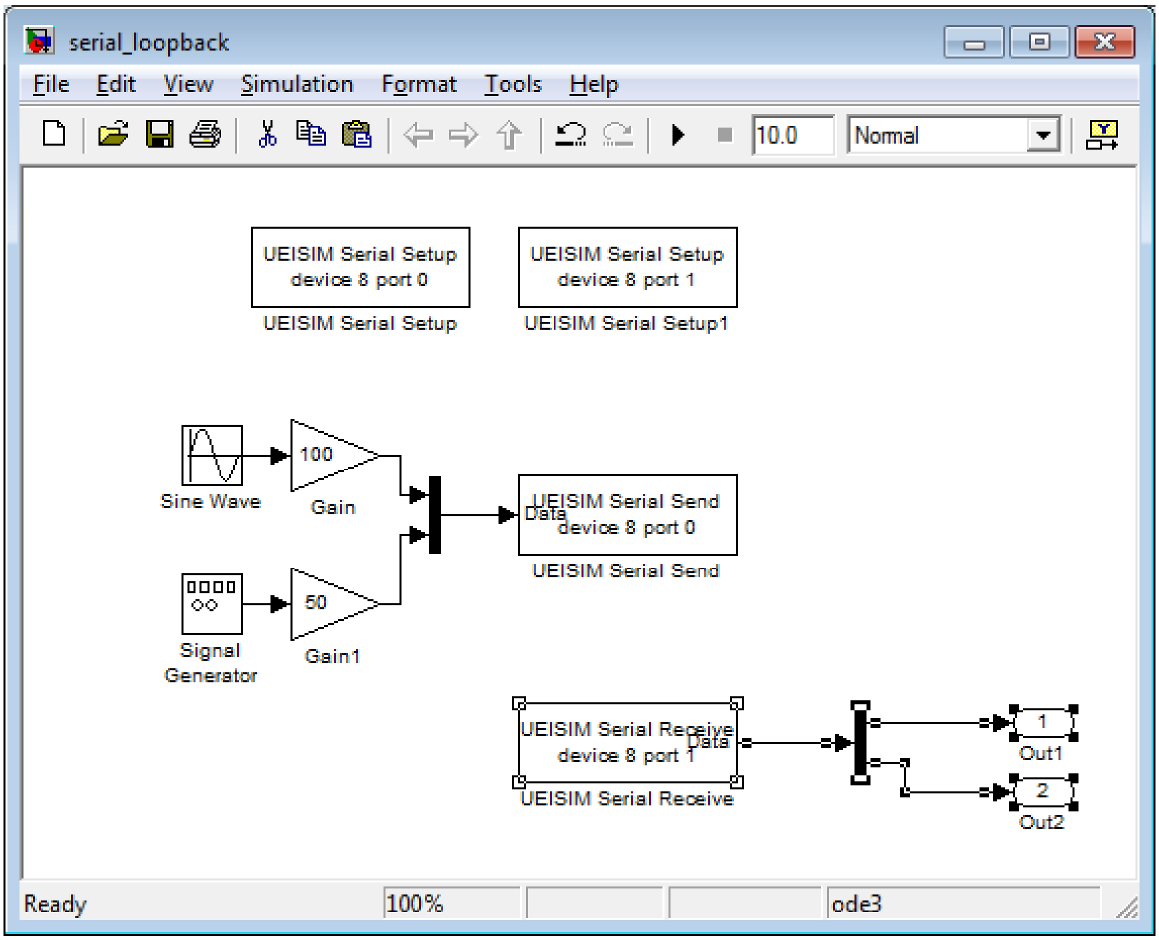
The block displays two output ports:
* Data: The signals extracted from the packet payload.
* Status: The status (see below).

The status output when enabled can take any of the following values:
* 0: No bytes were received
* N: Number of bytes received
* -1: A hardware error occurred
* -2: Buffer overrun, The receive block is not executed often enough to keep up with the pace of incoming bytes

Use the demux block to separate received data into individual signals.

### 5.11.4. Serial example

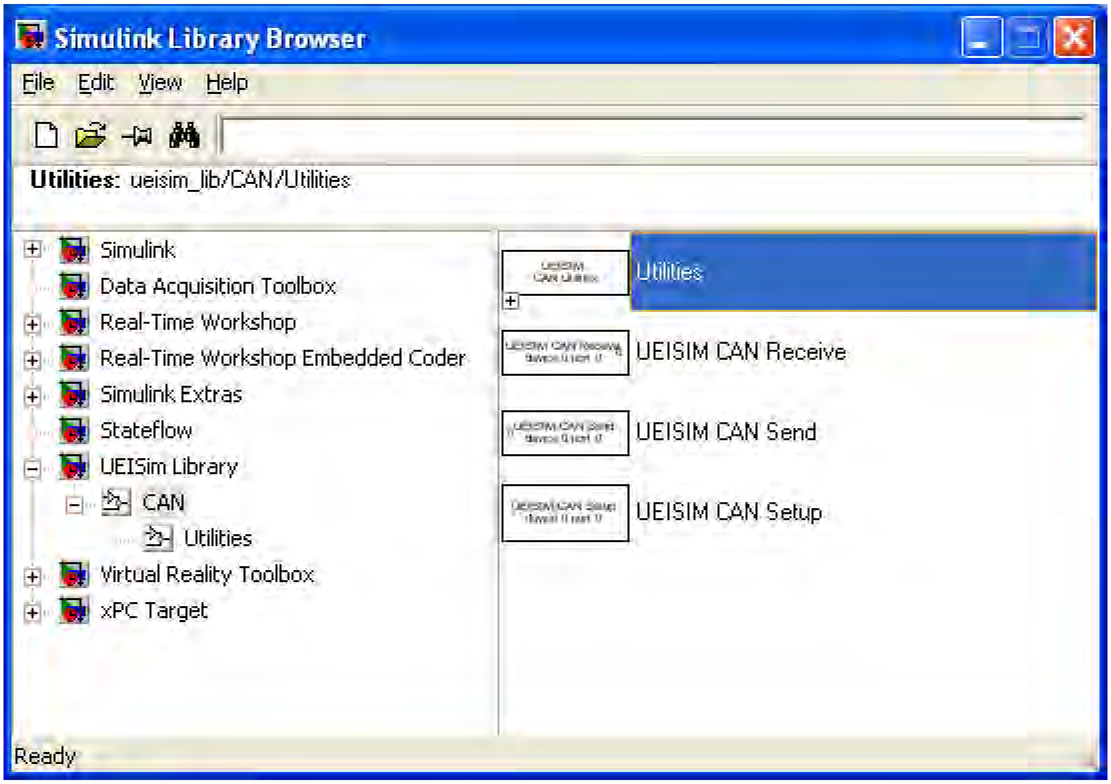
The following example sends simulated data to one port receive data from another port. This example will read back the data sent if both ports are connected with a NULL modem cable.




## 5.12. CAN bus communication

CAN communication blocks give access to the CAN-503 CAN ports. The configuration of each port is done using an independent setup block.
Sending and receiving CAN frames to/from a port is done using a send or receive block.

The High-Performance Alternative

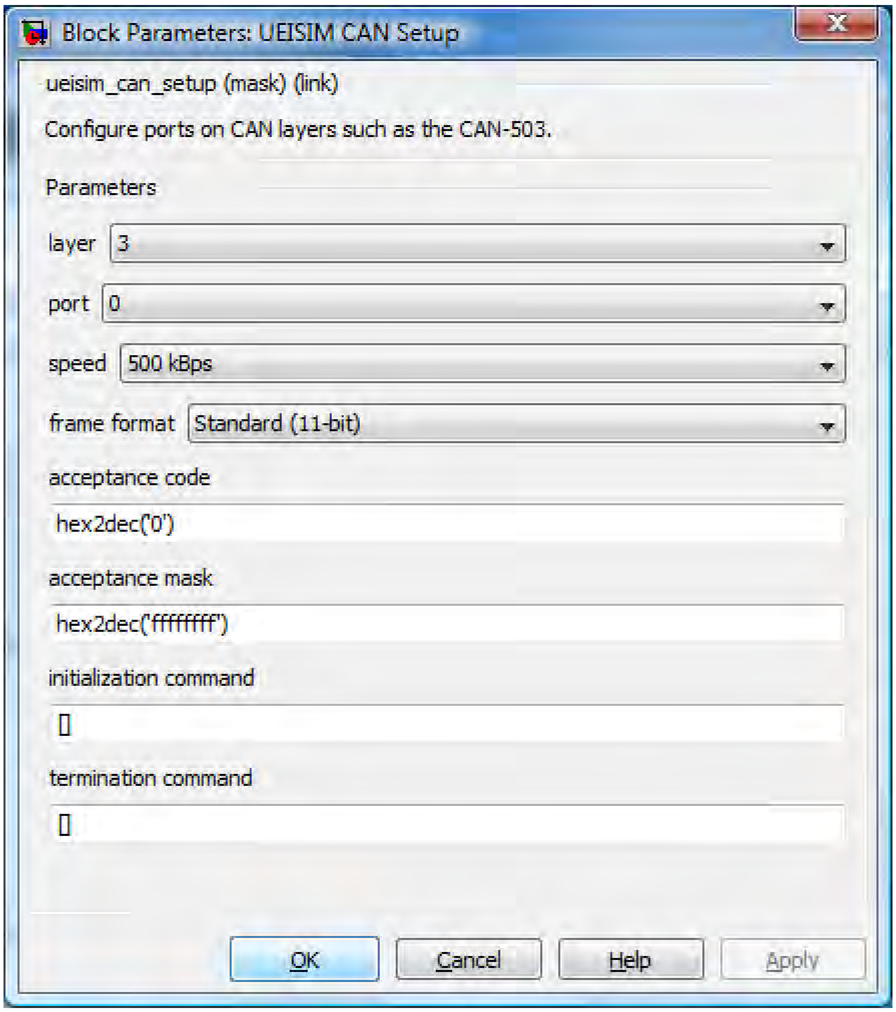



### 5.12.1. CAN Setup block

Configure communication settings on a given CAN port.

The setup block needs to run before the Send/Receive blocks are called (otherwise an error will be returned during model execution).
To view/change the execution context order: Select the menu option **Format > Block Displays > Sorted Order** and make sure that the setup block has a priority lower than the send and receive block for the same port.
To change a block priority: Right-click the block and select **Block Properties**. On the General tab, in the Priority field, enter the new priority.

There must be one setup block for each port used in the model.



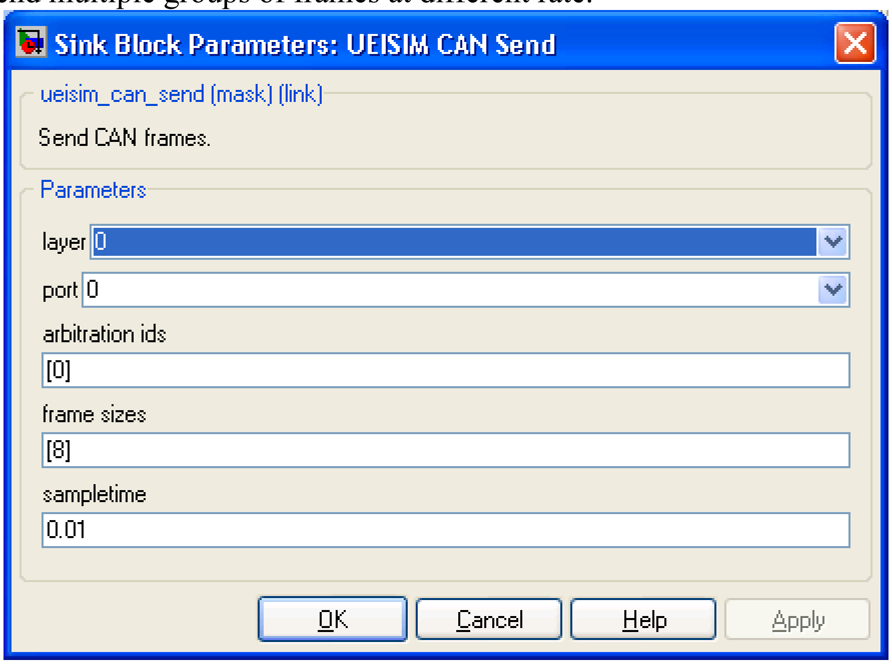

- **layer**: The Id of the CAN layer associated with this block (layer Ids start at 0 with the top layer)
- **port**: The Id of the port to configure (port Ids start at 0)
- **speed**: The speed in bits/s used on the CAN bus connected to this port
- **frame format**: The type of frame sent or received (Standard or Extended)
- **acceptance code**: Acceptance filter code configuration
- **acceptance mask**: Acceptance filter mask configuration
- **initialization command**: A sequence of frames to send to the CAN bus right before the model start.
- **Termination command**: A sequence of frames to send to the CAN bus right before the model terminates.

The initialization and termination sequences use the following format [ id1 len1 dataMSB1 dataLSB1 id2 len2 dataMSB2 dataLSB2 …]. For example to send a CAN frame with ID 0x12 and 5 bytes of data (0x01 0z02 0x03 0x04 0x05) use the following:

```
[ hex2dec('12') 5 hex2dec('05') hex2dec('04030201')]
```

### 5.12.2. CAN Send block

Send a group of CAN frames to one CAN port. You can create multiple instance of this block to send multiple groups of frames at different rate.



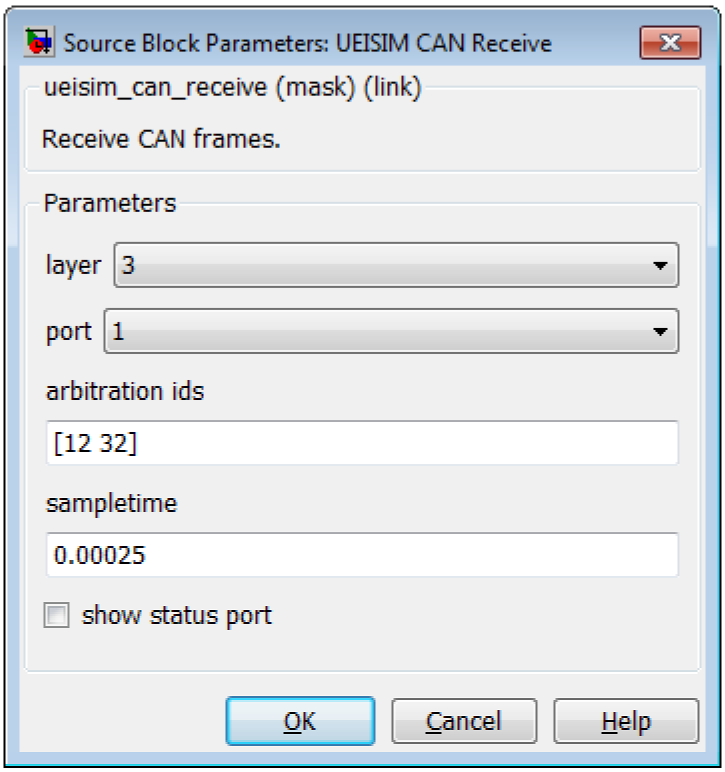

- **layer**: The Id of the CAN layer associated with this block (layer Ids start at 0 with the top layer)
- **port**: The Id of the port to send to (port Ids start at 0)
- **arbitration ids**: A list of arbitration IDs to send
- **frame sizes**: The size of the data payload for each frame
- **sample time**: The rate at which the block executes during simulation

The block displays an input port for connecting the value of the data payload for each frame.
The data payload is specified using the double data type, which is big enough to carry the 64 bits required for a full payload (8 bytes maximum).

Refer to section about packing/unpacking data into payload below.

### 5.12.3. CAN Receive block

Receive a group of CAN frames from one CAN port. You can create multiple instance of this block to receive multiple groups of frames at different rate.




- **layer**: The Id of the CAN layer associated with this block (layer Ids start at 0 with the top layer)
- **port**: The Id of the port to receive from (port Ids start at 0)
- **arbitration ids**: A list of arbitration IDs to receive
- **sample time**: The rate at which the block executes during simulation
- **Show Status Port**: Enable/disable status reporting

The block outputs the value of the data payload of each frame.
The data payload is specified using the double data type which is big enough to carry the 64 bits required for a full payload (8 bytes maximum).

Refer to section about packing/unpacking data into payload below.

The status output when enabled can take any of the following values:

- 0: No CAN frame was received, the signal output contains the data of the last received frame
- 1: A new CAN frame was received
- -1: A bus error occurred
- -2: Buffer overrun, The receive block is not executed often enough to keep up with the pace of incoming frames

### 5.12.4. Utility blocks

Utility blocks are used to pack and unpack data stored in the payload of CAN frames that are sent or received. You can specify the data types and position of multiple signals within a single CAN frame.

Each signal is specified using four parameters:

- data type: the type of the signal, possible values are boolean, int8, uint8, int16, uint16, int32, uint32, single or double.
- endianness: the endianness of the signal, possible values are:
  **intel** for little endian. Bits are counted to the left from the start bit.Bytes are also counted to the left.
  **motorola** for big endian, Bits are counted to the left from the start bit. Bytes are counted to the right.
  **alorotom** for backward Motorola format. Bits are counted to the left from the start bit. Bytes are counted to the right and the byte counting sequence is reversed.
- start bit: defines where the least significant bit of a signal's least significant byte is inserted into the message. It is always (even for big endian signals) counted from the start of the message (bit 0), and can be in the range (0..63).
- bit length: the number of bits used to represent the signal in the 8 bytes data payload.

#### *5.12.4.1. Intel format*

The least significant bit position, lsb, is specified as the start bit for signals in Intel format. The bits in an Intel CAN message are always counted as described in the layout below:

| Bit number within a byte | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **7** | **5** | **6** | **4** | **3** | **2** | **1** | **0** | | |
| 7<br>**X** | 6<br>**X** | 5<br>**X** | 4<br>**X** | 3<br>**X** | 2<br>**>lsb** | 1 | 0 | **0** | Byte number within CAN message |
| 15 | 14 | 13 | 12 | 11<br>**msb<** | 10<br>**X** | 9<br>**X** | 8<br>**X** | **1** | |
| 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | **2** | |
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | **3** | |
| 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 | **4** | |
| 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | **5** | |
| 55 | 54 | 53 | 52 | 51 | 50 | 49 | 48 | **6** | |
| 63 | 62 | 61 | 60 | 59 | 58 | 57 | 56 | **7** | |

In the example above, a ten-bit long message begins at start bit 2 (the lsb of the LSB is at position 2), counting upward from the start of the message.

#### *5.12.4.2. Motorola format*

The start bit specifies the position of the least significant bit in Motorola format.
The bits in a Motorola CAN message are always counted as described in the layout below:

| Bit number within a byte | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **7** | **5** | **6** | **4** | **3** | **2** | **1** | **0** | | Byte number within CAN message |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | **0** | |
| 15 | 14 | 13<br>**msb<** | 12<br>**X** | 11<br>**X** | 10<br>**X** | 9<br>**X** | 8<br>**X** | **1** | |
| 23<br>**X** | 22<br>**X** | 21<br>**X** | 20<br>**X** | 19<br>**X** | 18<br>**>lsb** | 17 | 16 | **2** | |
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | **3** | |
| 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 | **4** | |
| 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | **5** | |
| 55 | 54 | 53 | 52 | 51 | 50 | 49 | 48 | **6** | |
| 63 | 62 | 61 | 60 | 59 | 58 | 57 | 56 | **7** | |

In the example above, a twelve-bit long message begins at start bit 18 (the lsb of the LSB is at position 8), counting downward from the start of the message.

#### *5.12.4.3. CAN pack block*

Pack multiple signals into one CAN message. Signals are encoded using data type and position of bits in message.

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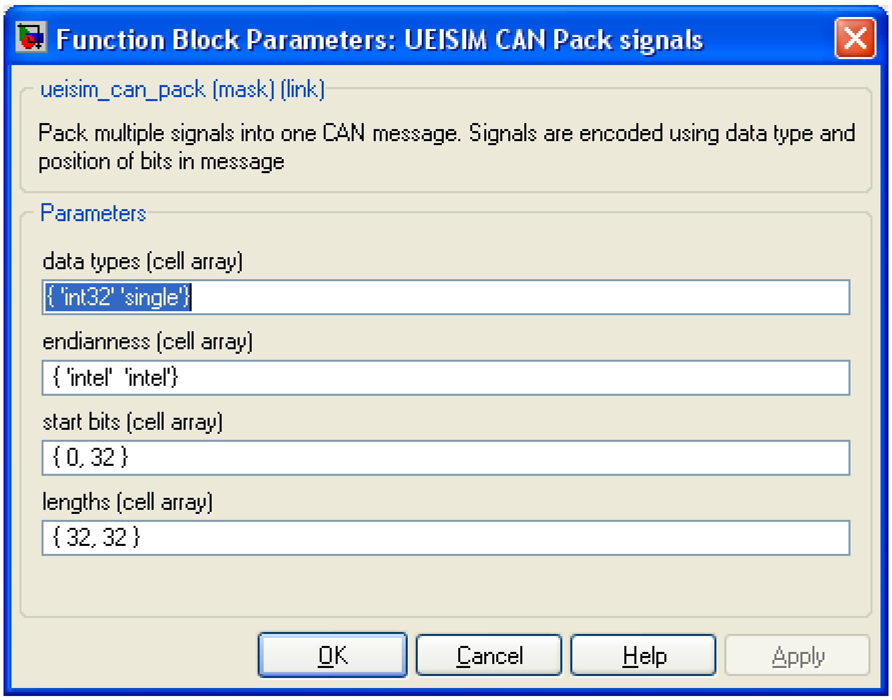


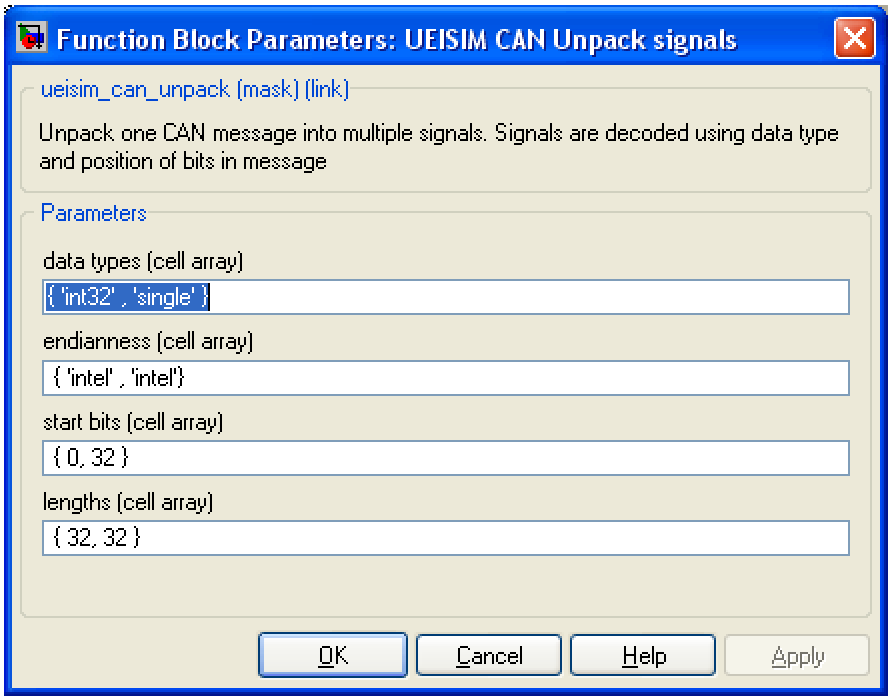

- **Data types**: A cell array containing the data types of the signals to pack in the message
- **Endianness**: A cell array containing the endianness of the signals to pack
- **Start bits**: A cell array containing the index of the first bit of the signals to pack
- **Bit length**: A cell array containing the number of bits of the signals to pack

The block automatically converts itself to one with the correct number of input ports. There is always one output port. The output value is ready to be connected to the CAN Send block.

#### *5.12.4.4. CAN unpack block*

Unpack one CAN message into multiple signals. Signals are decoded using data type and position of bits in message

The High-Performance Alternative

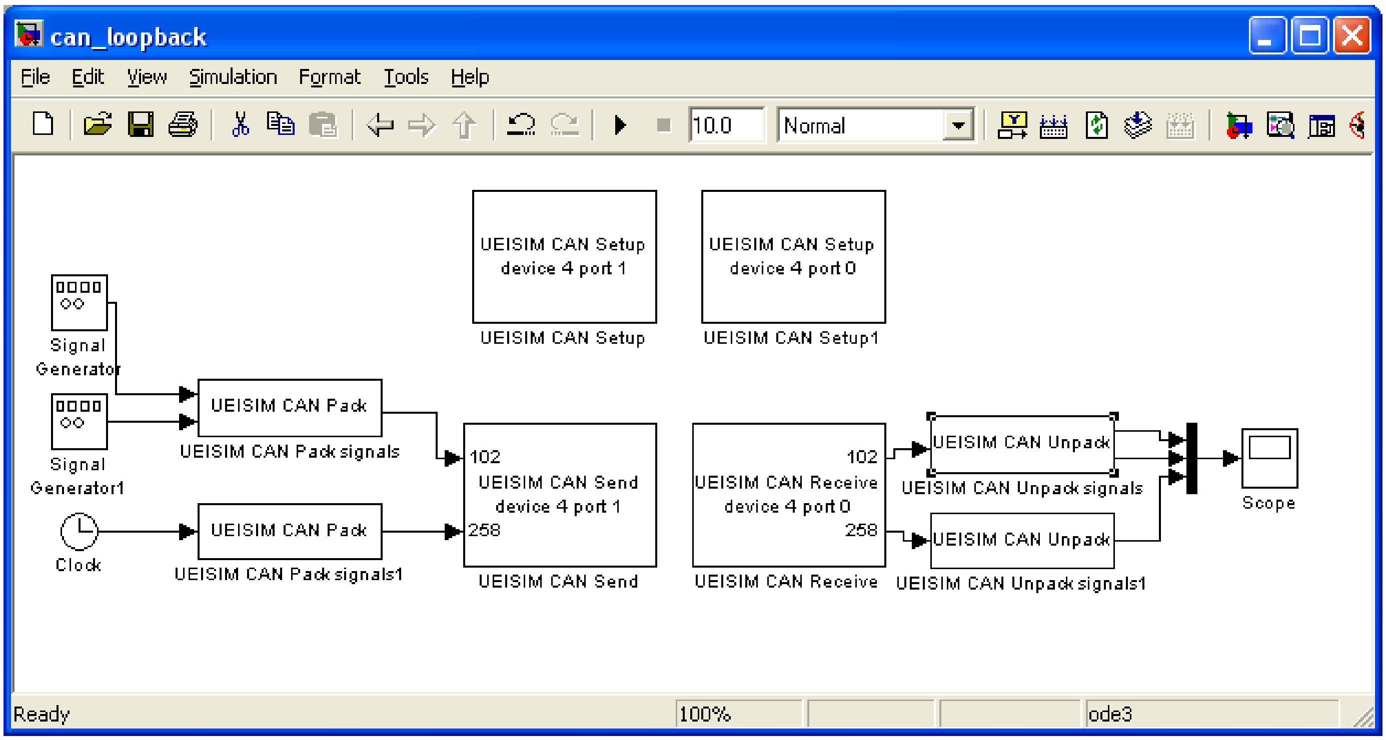



- **Data types**: A cell array containing the data types of the signals to unpack from the message
- **Endianness**: A cell array containing the endianness of the signals to unpack
- **Start bits**: A cell array containing the index of the first bit of the signals to unpack
- **Bit length**: A cell array containing the number of bits of the signals to unpack

The block displays one input port to connect a double value coming from the CAN Receive block. It also displays an output port for each signal to unpack from the CAN message.

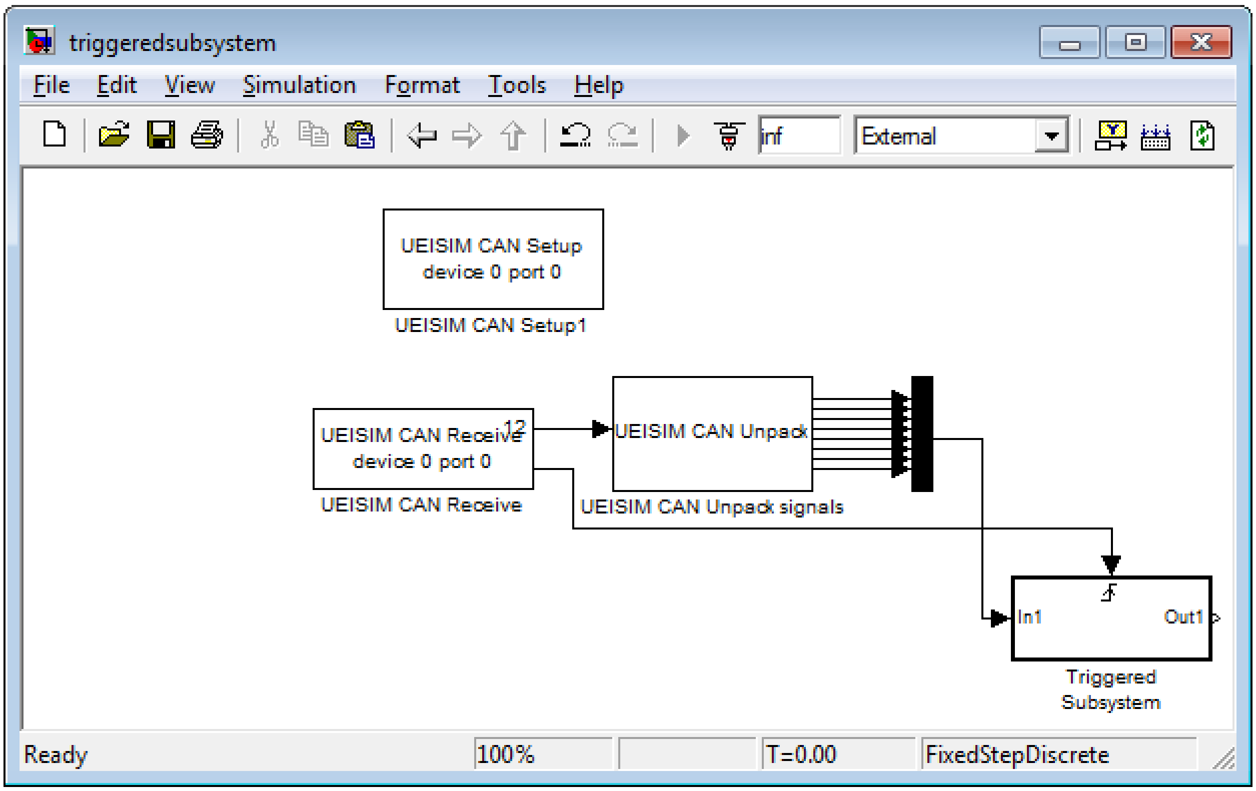
### 5.12.5. CAN examples

The following example configures two ports on the same CAN-503, sends frames with Ids 102 and 258 out of port 0 and receives frames with Ids 102 and 258 from port 1.
If port 0 and port1 are connected to the same CAN bus, you will receive what you send.



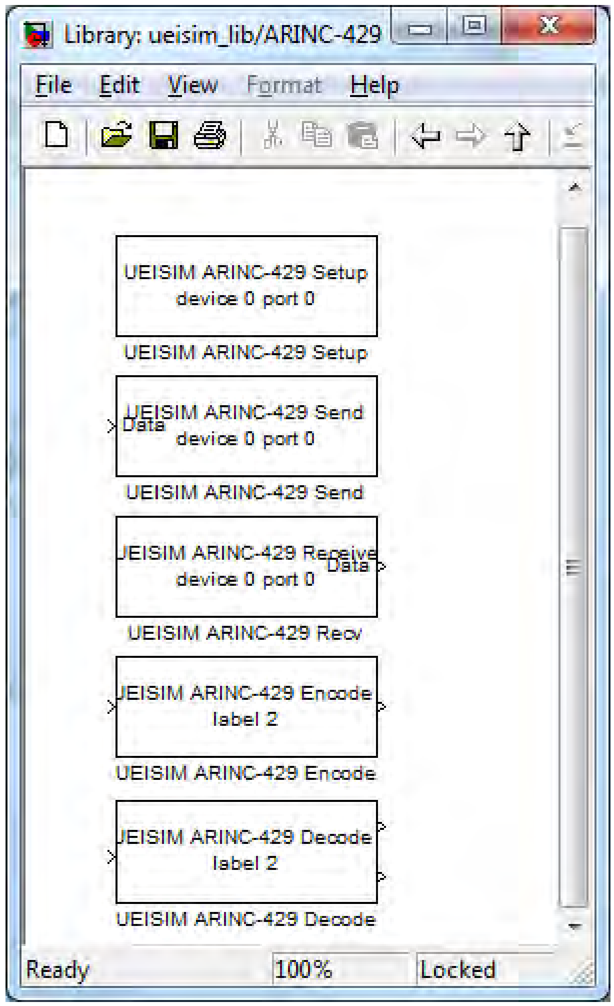

The example below shows how the status output can trigger a subsystem to only execute portion of your model when a fresh CAN frame has been received.

The triggered subsystem “Trigger Type” is configured to “Rising”. It will execute when the CAN Receive status goes from 0 to 1 each time a new CAN frame is received.




## 5.13. ARINC-429 communication

ARINC-429 communication blocks give access to the 429-566 and 429-512 ARINC-429 ports.
The configuration of each port is done using an independent setup block.
Sending and receiving ARINC-429 words to/from a port is done using a send or receive block.

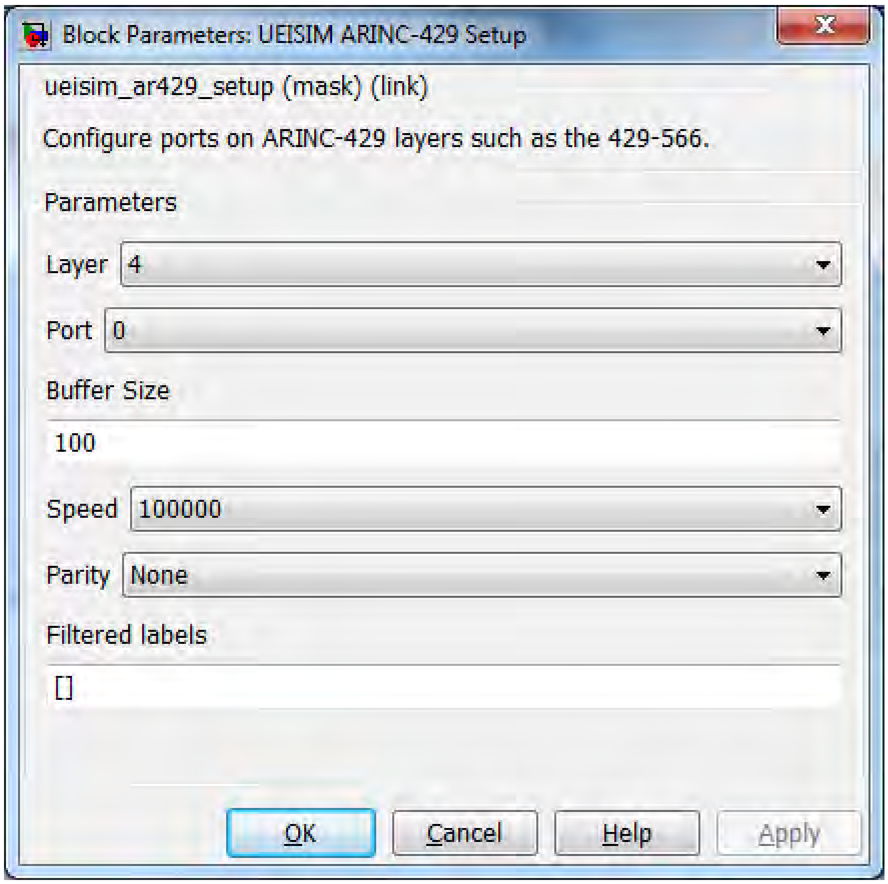



### 5.13.1. ARINC-429 Setup block

Configure communication settings on a given ARINC-429 port.

The setup block needs to run before the Send/Receive blocks are called (otherwise an error will be returned during model execution).
To view/change the execution context order: Select the menu option **Format > Block Displays > Sorted Order** and make sure that the setup block has a priority lower than the send and receive block for the same port.
To change a block priority: Right-click the block and select **Block Properties**. On the General tab, in the Priority field, enter the new priority.

There must be one setup block for each port used in the model.




- **layer**: The Id of the ARINC-429 layer associated with this block (layer Ids start at 0 with the top layer)
- **port**: The Id of the port to configure (port Ids start at 0)
- **buffer size**: the size of the internal buffer allocated to store incoming words until they are actually received in the model.
- **speed**: The speed in bits/s used on the ARINC-429 bus connected to this port
- **parity**:The parity setting. Set it to None to have full control of the parity bit.
- **Filtered labels**: A sequence of labels to program the hardware filter. Matching words will be rejected by the ARINc-429 port.

### 5.13.2. ARINC-429 Send block

Send a group of words to one ARINC-429 TX port. You can create multiple instances of this block to send multiple groups of words at different rate.

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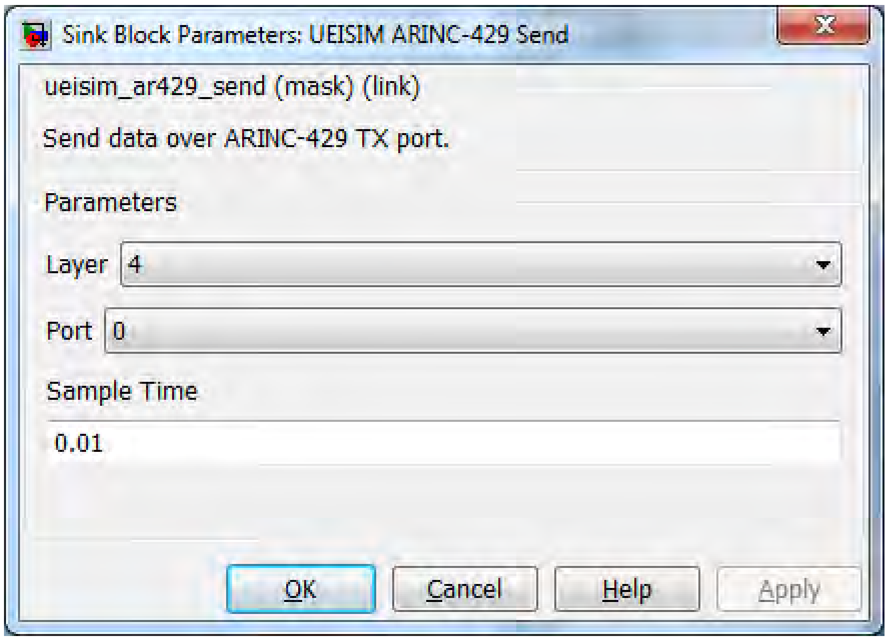



- **Layer**: The Id of the ARINC-429 layer associated with this block (layer Ids start at 0 with the top layer)
- **Port**: The Id of the port to send data through (port Ids start at 0)
- **Sample Time**: The rate at which the block executes during simulation

The block displays an input port for connecting an array of type UINT32 containing raw values for each word to transmit.

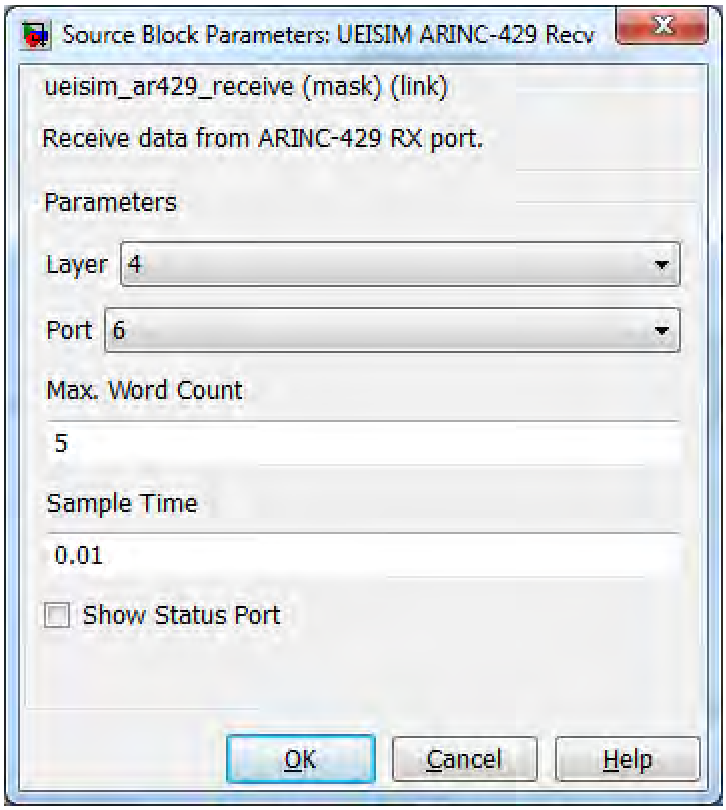
Raw word is a 32 bits value coded as follow:

<table>
<tr><td>32</td><td>31</td><td>30</td><td>29 11</td><td>10</td><td>9</td><td>8 1</td></tr>
<tr><td>P</td><td colspan="2">SSM</td><td>Data</td><td colspan="2">SDI</td><td>Label</td></tr>
</table>

Use the ARINC-429 Encode block to encode a value using BCD, BNR or Discrete data type in the data field.
Refer to section about encoding/decoding words below.

### 5.13.3. ARINC-429 Receive block

Receive a group of ARINC-429 words from one RX port. You can create multiple instances of this block to receive multiple groups of words at different rate.




- **layer**: The Id of the ARINC-429 layer associated with this block (layer Ids start at 0 with the top layer)
- **port**: The Id of the port to receive from (port Ids start at 0)
- **max. word count**: The maximum number of word to read from the receive buffer
- **sample time**: The rate at which the block executes during simulation
- **Show Status Port**: Enable/disable status reporting

The block outputs a signal of type UINT32. The first value in the array contains the number of words actually retrieved followed by the raw values of each word.

Raw word is a 32 bits value coded as follow:

| | | | | | | |
|---|---|---|---|---|---|---|
| 32 | 31 | 30 | 29 11 | 10 | 9 | 8 1 |
| P | SSM | | Data | SDI | | Label |

Refer to section about encoding/decoding data field into word below.

The status output when enabled can take any of the following values:

- N>=0: Number of words still available in the receive buffer

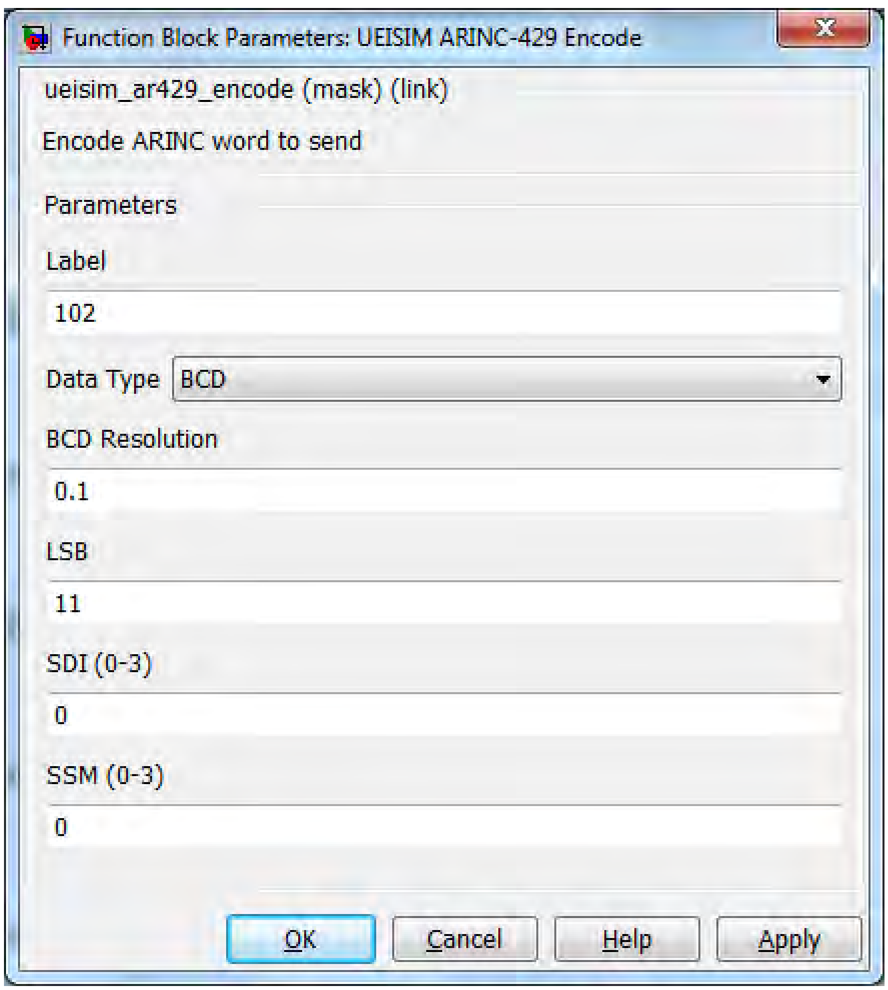
- -2: RX Buffer overrun, The receive block is not executed often enough to keep up with the pace of incoming words

### 5.13.4. ARINC-429 Encode block

Create ARINC-429 raw word and encode value using raw, discrete, BCD or BNR format.

#### *5.13.4.1. BCD*

Scale and convert the input as a signed integer, limit it to the range representable by an ARINC five-character BCD value, and pack it into an ARINC word with the appropriate SSM, SDI, and Label parameter values.

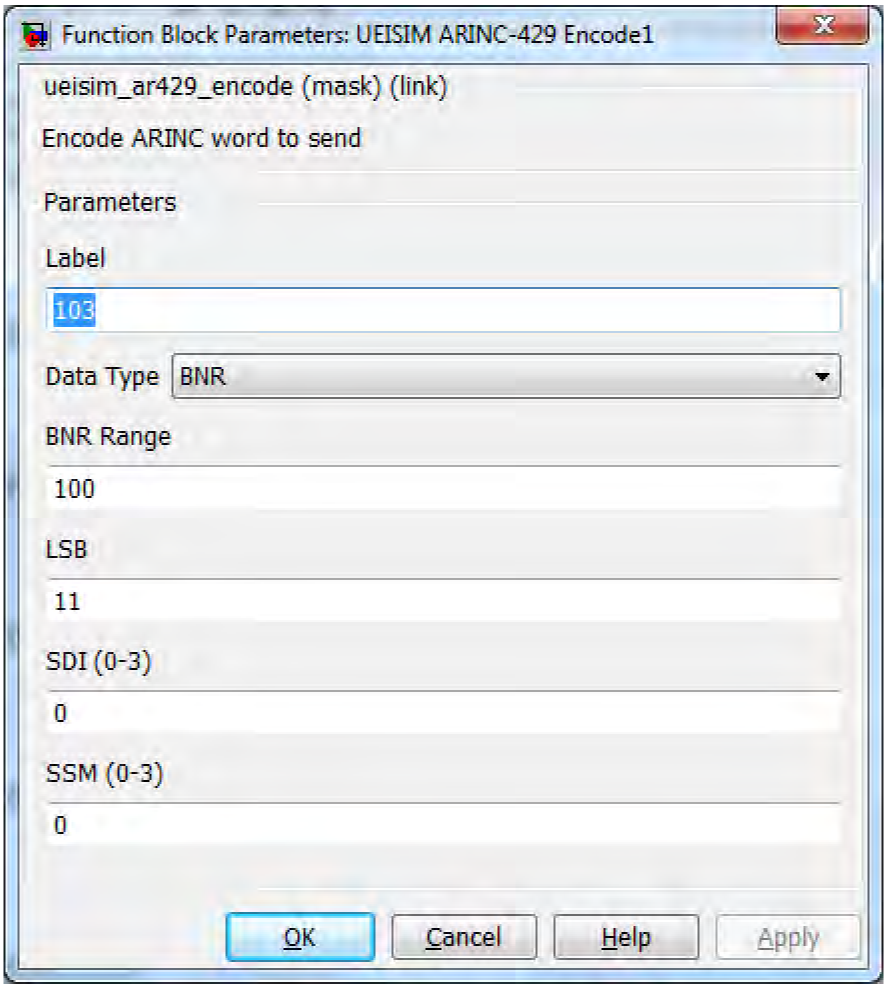



- **label**: The 8-bit value inserted in the label field of the word sent over the output port
- **data type**: data type selector

- **BCD resolution**: the value of the least significant digit of the BCD data field to be encoded and sent. For example, if the associated resolution is .01 and the input signal contains the value 3.1415, the output ARINC word will contain the number 314 in its data field, encoded in BCD.
- **lsb**: defines where the encoded value is inserted in the ARINC word. Default is 11.
- **sdi**: if in the range 0 to 3, the block sets the SDI field of the word sent over the output port
- **ssm**: if in the range 0 to 3, the block sets the SSM field of the word sent over the output port

#### *5.13.4.2. BNR*

Scale the input and convert to two's complement binary notation, then pack it into an ARINC word with the appropriate SSM, SDI, and Label parameter values.




- **label**: The 8-bit value inserted in the label field of the word sent over the output port
- **data type**: data type selector
- **BNR range**: scale factor used to scale the input value which is then limited to [-range, range]. Input values outside that range will be limited to ±range.
- **lsb**: defines where the encoded value is inserted in the ARINC word. Default is 11.
- **sdi**: if in the range 0 to 3, the block sets the SDI field of the word sent over the output port
- **ssm**: if in the range 0 to 3, the block sets the SSM field of the word sent over the output port

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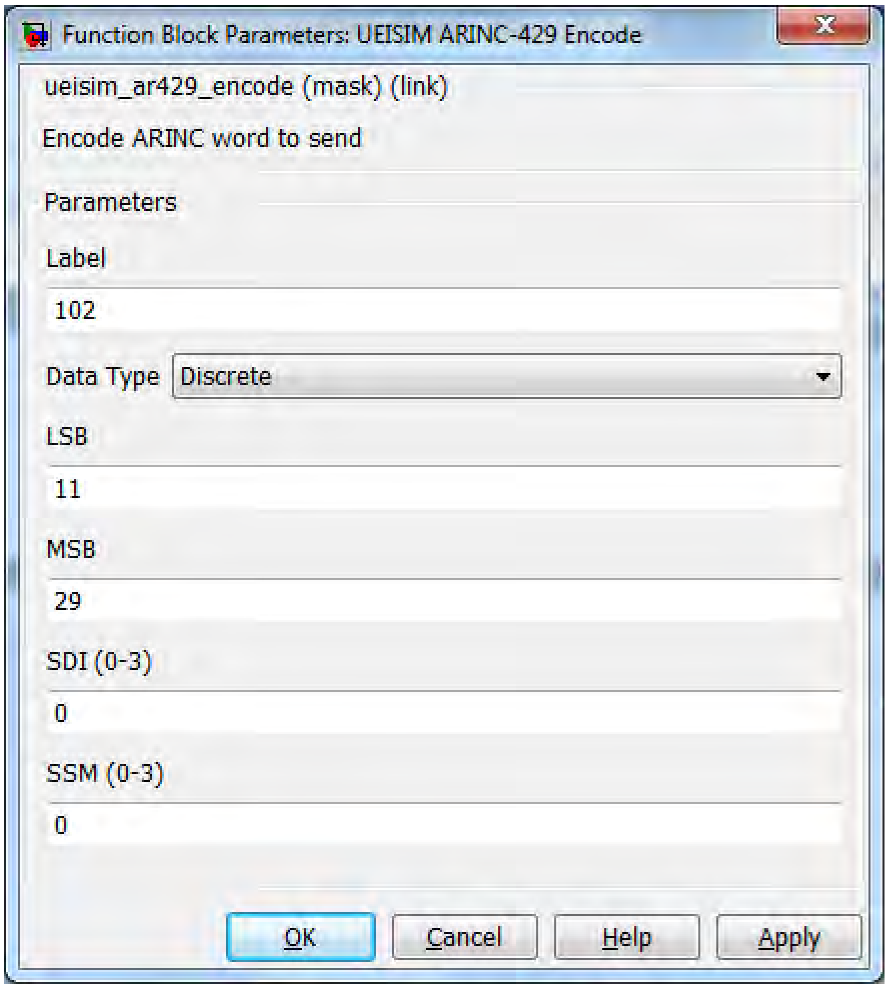
#### 5.13.4.3. *Discrete*

Cast the input as an UINT32 and insert the low order 19 bits in the data field of the ARINC word along with the appropriate SSM, SDI, and Label parameter values




- **label**: The 8-bit value inserted in the label field of the word sent over the output port
- **data type**: data type selector
- **lsb**: defines where the encoded value is inserted in the ARINC word. Default is 11.
- **msb**: defines how much of the encoded value is truncated. Default value is 29.
- **sdi**: if in the range 0 to 3, the block sets the SDI field of the word sent over the output port
- **ssm**: if in the range 0 to 3, the block sets the SSM field of the word sent over the output port

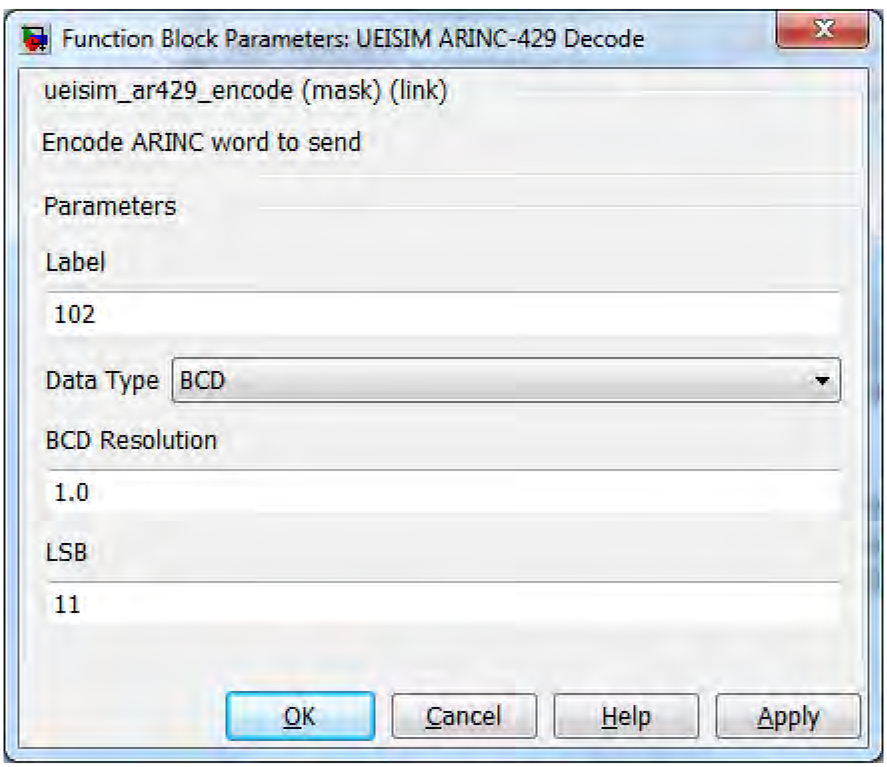
The High-Performance Alternative

#### *5.13.4.4. Raw*
Cast the input to an unsigned 32-bit integer and output it as an ARINC word with no further processing.

### 5.13.5. ARINC-429 Decode block
Compare label and decode raw word to scaled value.

The block displays one input port to connect a UINT32 coming from the ARINC-429 Receive block.
It also displays an output port for the decoded value and a status output port. Status is 0 if the input raw word's label field didn't match the label parameter and 1 otherwise.

#### *5.13.5.1. BCD*
Decode the data field from 5 digit BCD value to double.




- **label**: The 8-bit value to compare with the label field of the word received on the input
- **data type**: data type selector

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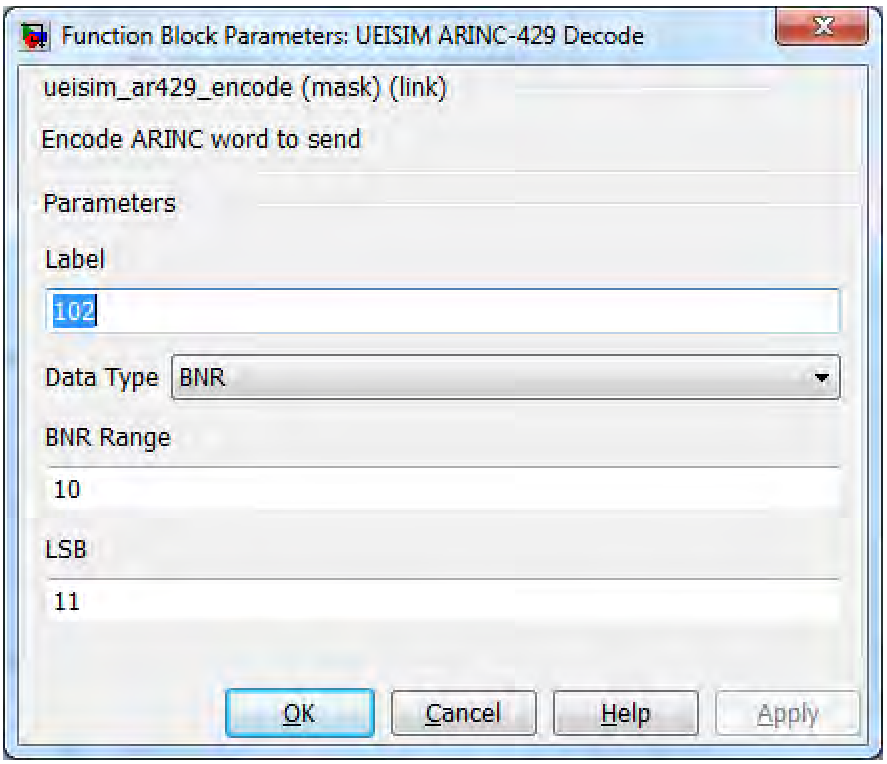
- **BCD resolution**: the value of the least significant digit of the BCD data field to be decoded.
- **lsb**: defines where the raw value is located in the input word. Default is 11.

#### *5.13.5.2. BNR*

Decode the data field from two's complement binary notation and apply scaling factor.

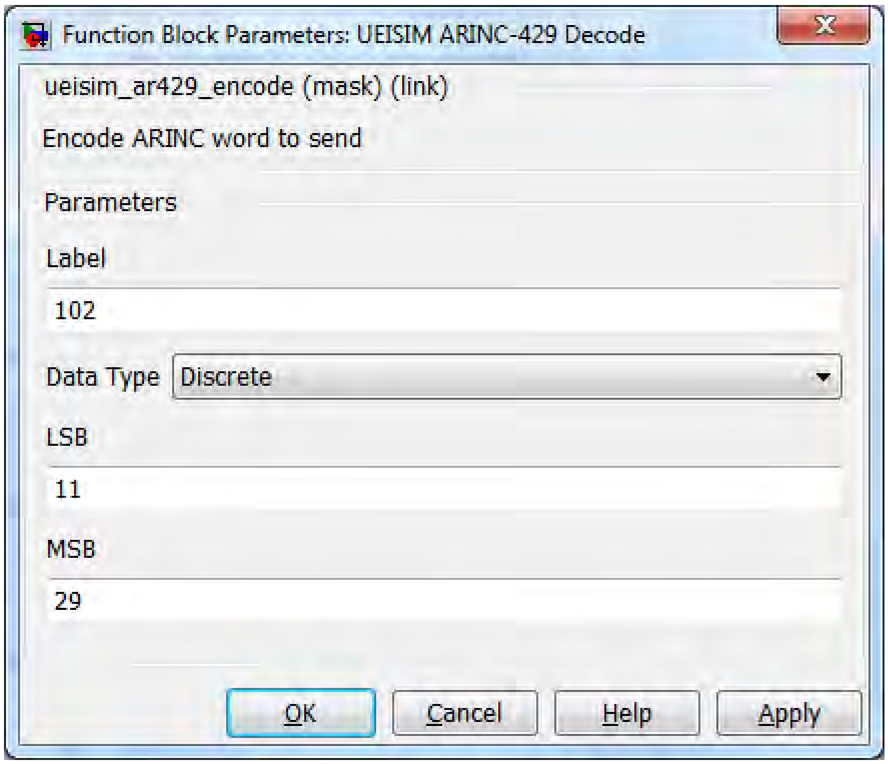



- **label**: The 8-bit value to compare with the label field of the word received on the input
- **data type**: data type selector
- **BNR range**: scale factor used to scale the coded value back to its original value.
- **lsb**: defines where the coded value is located in the ARINC word. Default is 11.

#### *5.13.5.3. Discrete*

Extract the data field from the input word and cast it as a double.

The High-Performance Alternative




- **label**: The 8-bit value inserted in the label field of the word sent over the output port
- **data type**: data type selector
- **lsb**: defines where the coded value is located in the ARINC word. Default is 11.
- **msb**: defines how much of the coded value to extract. Default value is 29.

##### *5.13.5.4. Raw*

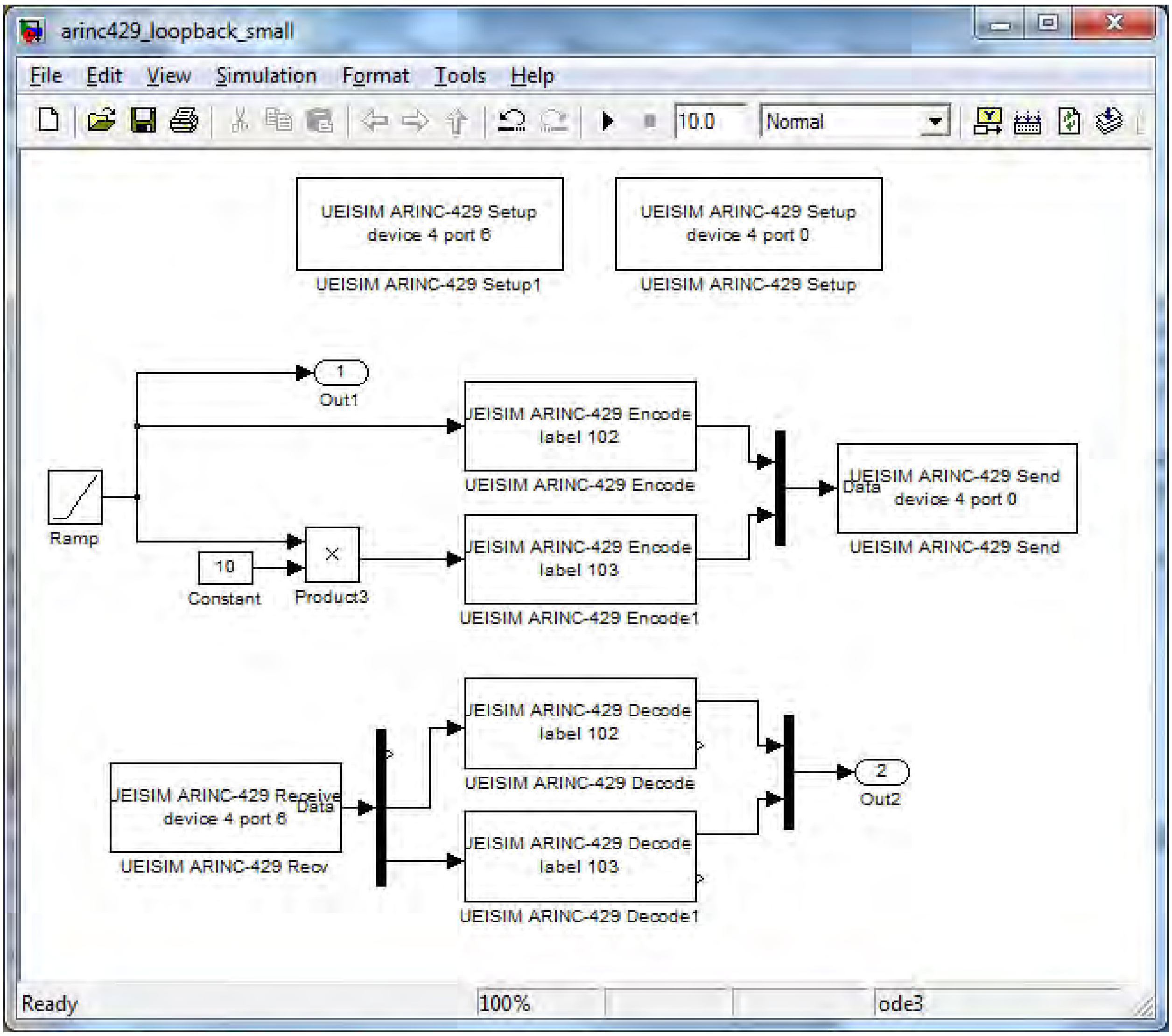
Cast the input to a double with no further processing

#### 5.13.6. ARINC-429 examples

The following example configures two ports 0 and 6 to run at the same speed. (On 429-566, port 6 is internal loopback port; it automatically receives whatever is transmitted out of port 0).

Port 0 transmits two words where the value from a ramp function block is encoded using BCD format and labels 102 and 103.

Port 6 receives those words and decodes them back using the same parameters than the encode block.




Note that the first output of the demux block connected to ARINC-429 receive is not connected. This output contains the number of words received and is ignored in this example.

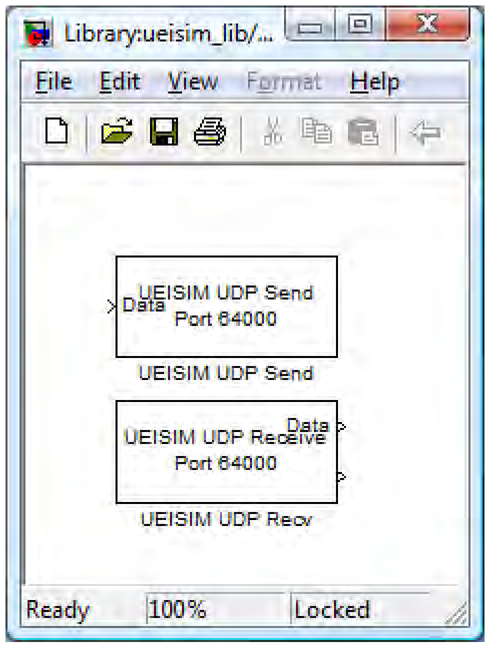
The status output of the ARINC-429 decode blocks is also ignored. You could connect it to a triggered subsystem that would execute when the decoder status goes from 0 to 1 (each time a word that matches the label parameter is decoded).

The High-Performance Alternative

## 5.14. Network communication

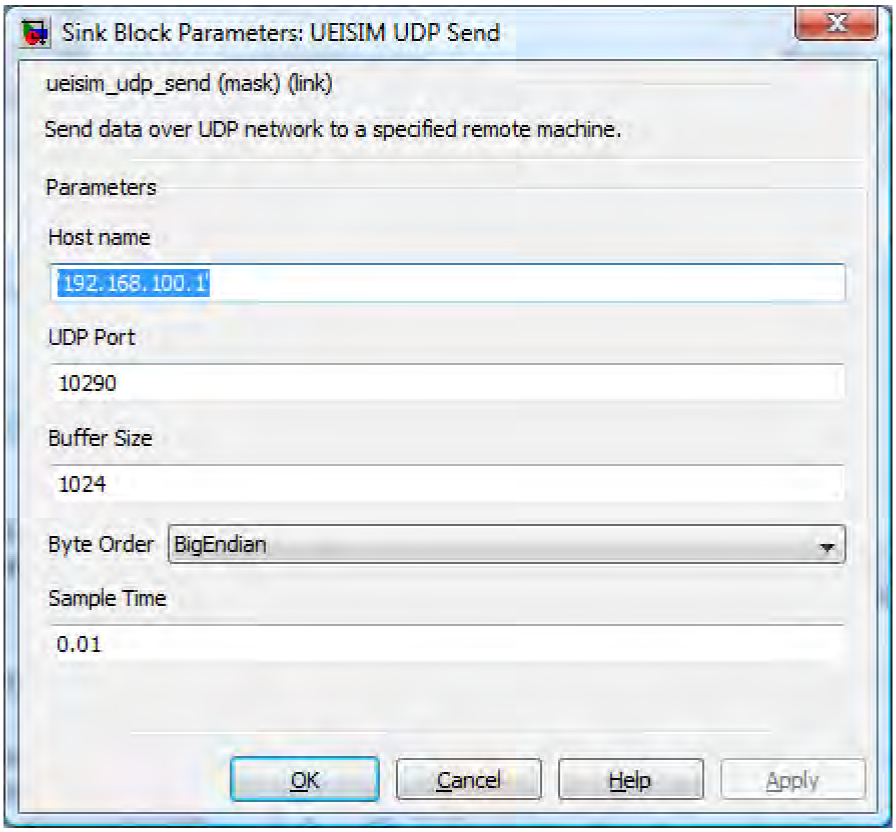
### 5.14.1. UDP

UDP communication blocks give access to the Ethernet port. Sending and receiving UDP packets to/from the Ethernet port is done using the UDP send or UDP receive block.




#### *5.14.1.1. UDP Send block*

Send UDP packets to a network host. You can create multiple instance of this block to send packets to different ports at different rates.

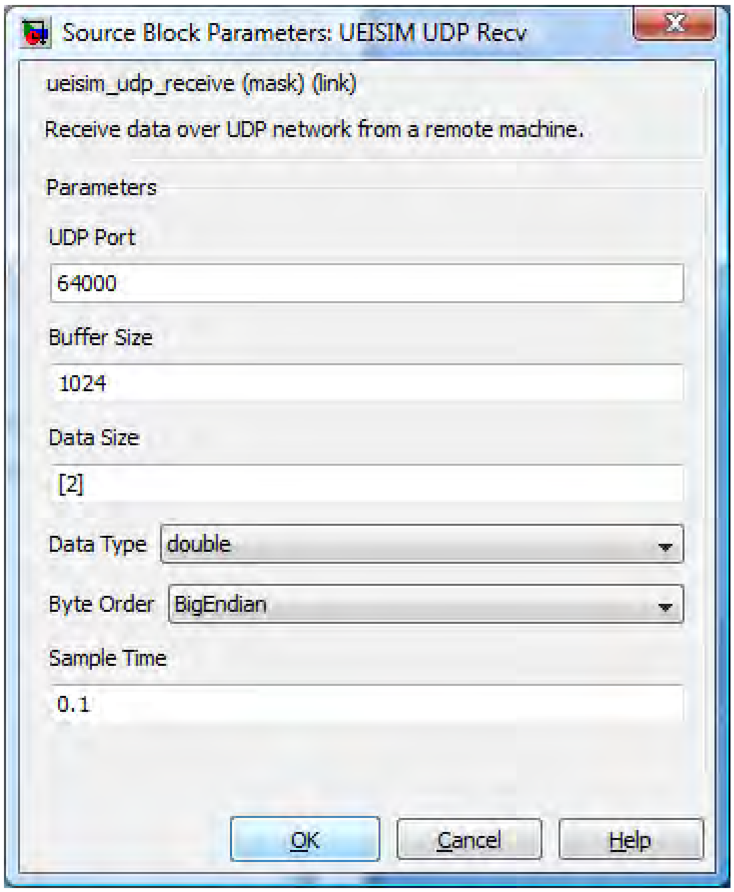



- **Host name**: The name or IP address of the destination host
- **UDP port**: The port to send to (must be > 1024 and < 65535)
- **Buffer size**: Size in bytes of the network buffer
- **Byte Order**: The endianness used to pack data in the UDP packet.
- **Sample Time**: The rate at which the block executes during simulation

The block displays an input port for connecting the value of the packet payload, it automatically adapts to the data type and dimension of the signal connected.

#### *5.14.1.2. UDP Receive block*

Receive UDP packets from a network host. You can create multiple instance of this block to receive multiple packets from different ports.




- **UDP port**: The port to receive from (must be > 1024 and < 65535)
- **Buffer size**: Size in bytes of the network buffer
- **Data Size**: Dimension and size of the output signal (for ex [2 4] will output received data in a 2x4 matrix)
- **Data Type**: The data type used to decode received data
- **Byte Order**: The endianness used to unpack the UDP packet payload.
- **Sample Time**: The rate at which the block executes during simulation

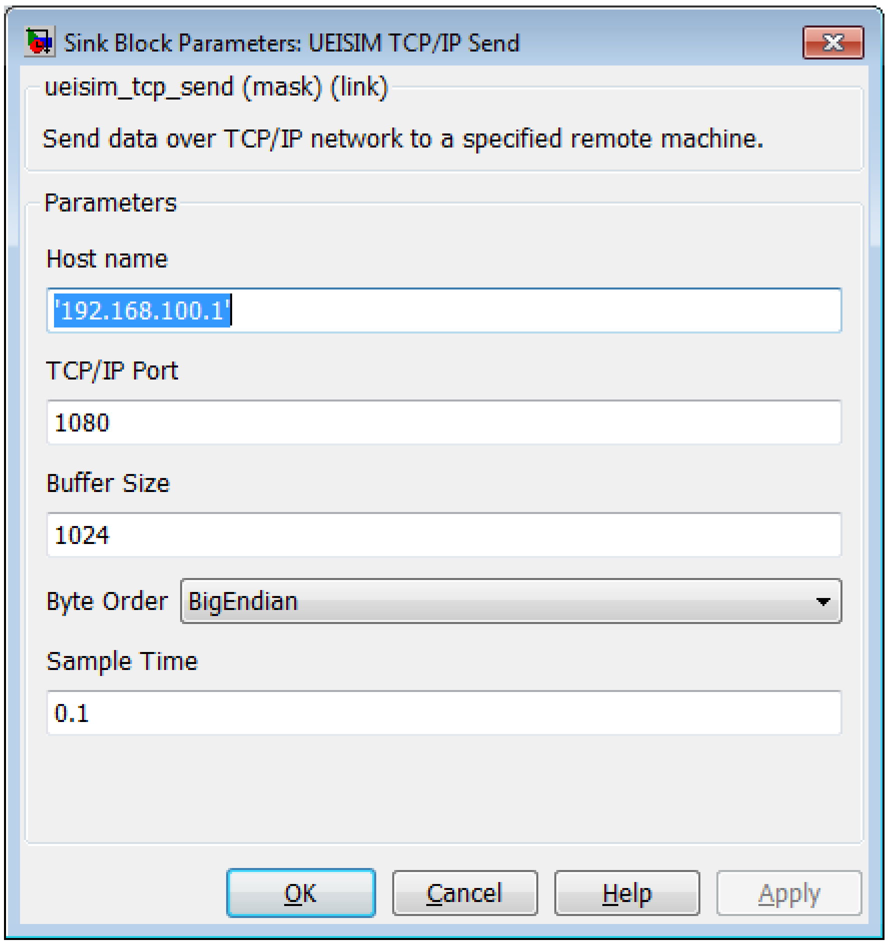
The block displays two output ports:

- Data: The signal extracted from the packet payload.
- Status: The number of bytes in the payload (0 if no packet was received).

### 5.14.2. TCP/IP Client

#### *5.14.2.1. TCP/IP Send block*

Send TCP/IP packets to a TCP/IP server. You can create multiple instance of this block to send packets to different servers at different rates.

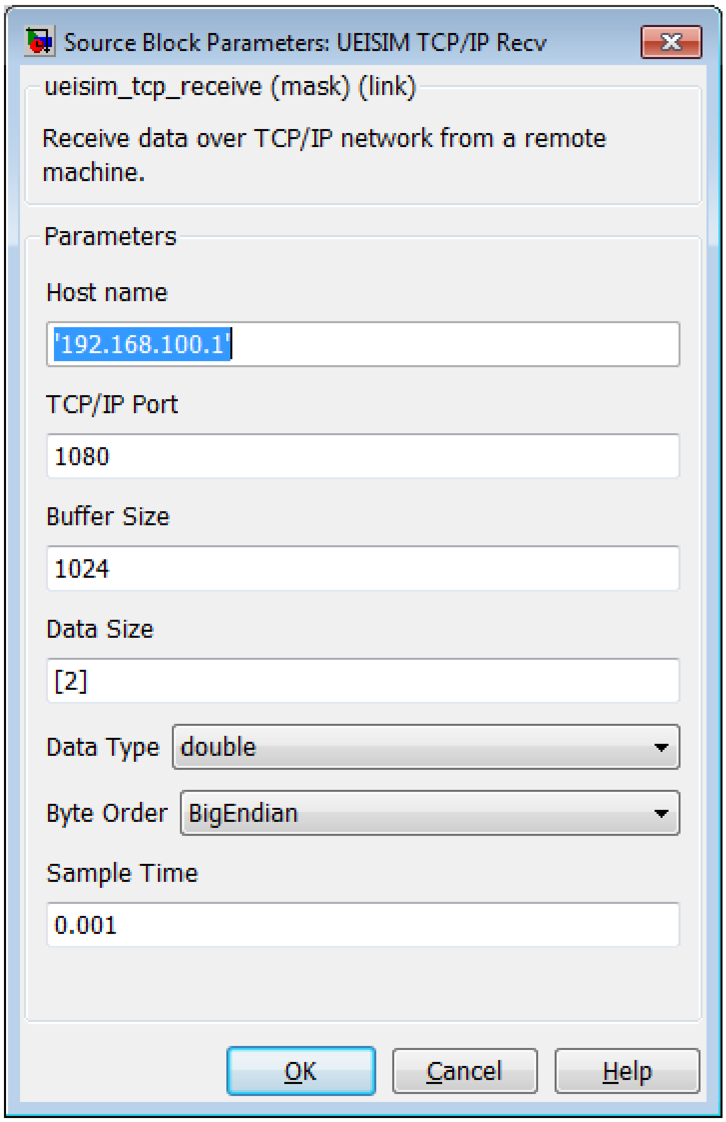



- **Host name**: The name or IP address of the server
- **TCP/Ip port**: The port to send to
- **Buffer size**: Size in bytes of the network buffer
- **Byte Order**: The endianness used to pack data in the TCP/IP packet.
- **Sample Time**: The rate at which the block executes during simulation

The block displays an input port for connecting the value of the packet payload, it automatically adapts to the data type and dimension of the signal connected.

#### *5.14.2.2. TCP/IP Receive block*

Receive TCP/IP packets from a server. You can create multiple instance of this block to receive multiple packets from different servers.




- **Host name**: The name or IP address of the server
- **TCP/IP port**: The port to receive from
- **Buffer size**: Size in bytes of the network buffer
- **Data Size**: Dimension and size of the output signal (for ex [2 4] will output received data in a 2x4 matrix)
- **Data Type**: The data type used to decode received data
- **Byte Order**: The endianness used to unpack the TCP/IP packet payload.
- **Sample Time**: The rate at which the block executes during simulation

The block displays two output ports:

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- Data: The signal extracted from the packet payload.
- Status: The number of bytes in the payload (0 if no packet was received).

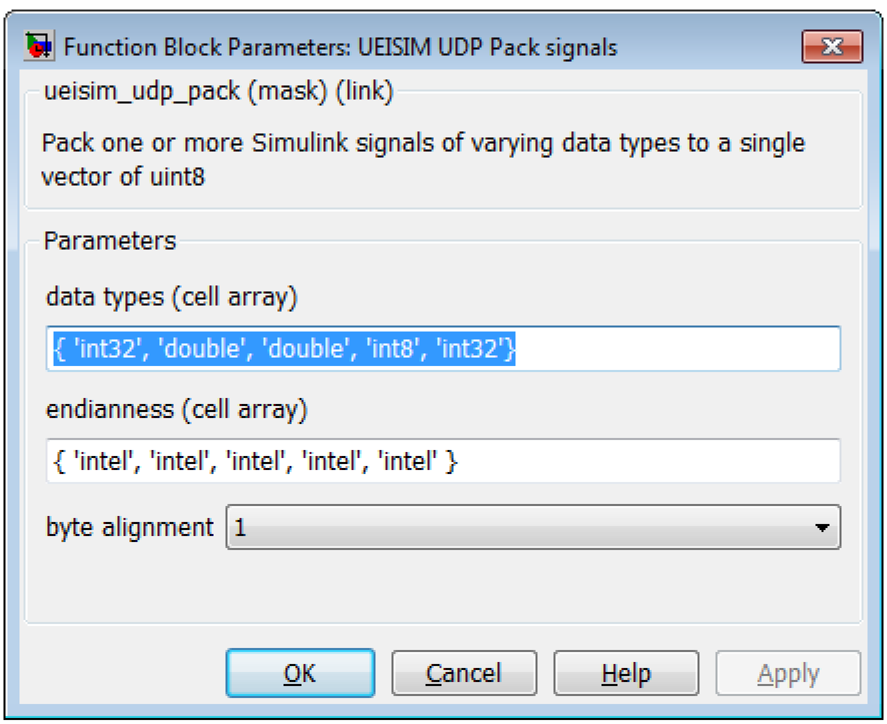
### 5.14.3. Utility blocks

Utility blocks are used to pack and unpack data structures stored in the TCP/IP or UDP packets that are sent or received. You can specify different data types for each member of the data structure.

Each member is specified using the following parameters:

- **data type**: the type of the member, possible values are boolean, int8, uint8, int16, uint16, int32, uint32, single or double.
- **endianness**: the endianness of the member, possible values are 'intel' for little endian, 'motorola' for big endian and 'alorotom' for backward Motorola format

#### *5.14.3.1. UEISIM Pack block*

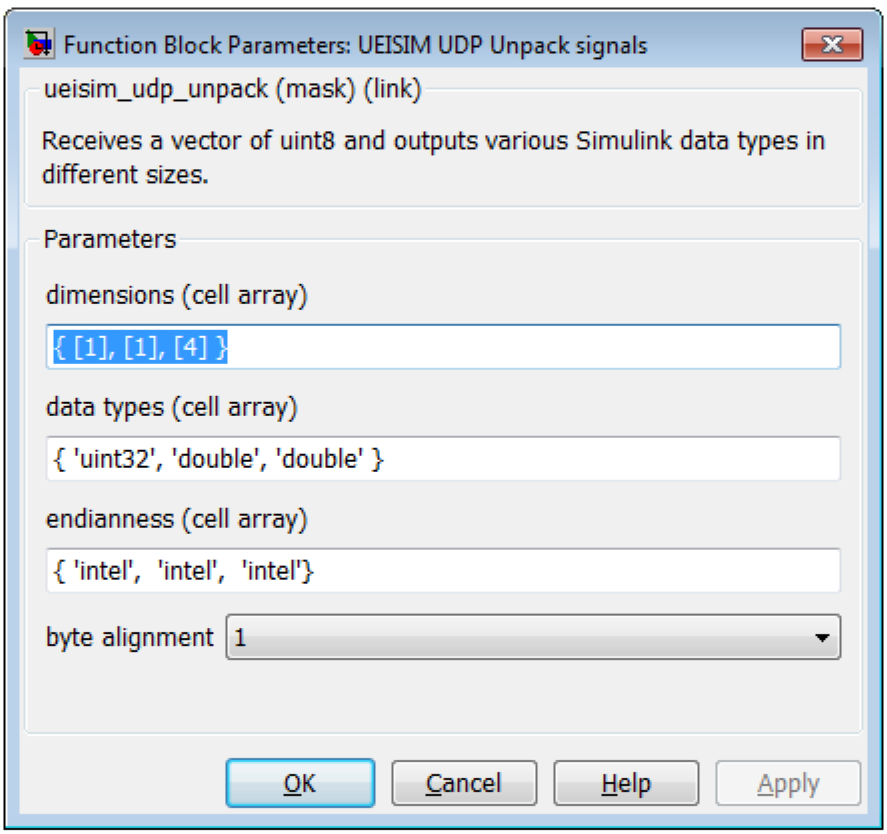



- **Data types**: A cell array containing the data types of the structure members to pack in the buffer
- **Endianness**: A cell array containing the endianness of the signals to pack

- **Byte alignment**: The minimum number of bytes occupied by each member. Possible values are 1,2,4 and 8. For example with align=4, int8 and uint8 members will occupy 4 bytes with 3 zero bytes for padding.

The block automatically converts itself to one with the correct number of input ports. There is always one output port of type uint8. The output value is ready to be connected to the UDP Send block.
The UEISIM UDP or TCP/IP Send block needs to be configured to send data of type **uint8**.

#### *5.14.3.2. UEISIM Unpack block*




- **Dimensions**: A cell array containing the dimensions (as returned by MATLAB size() function) of the corresponding signal.
- **Data types**: A cell array containing the data types of the structure members to unpack from the buffer
- **Endianness**: A cell array containing the endianness of the signals to unpack

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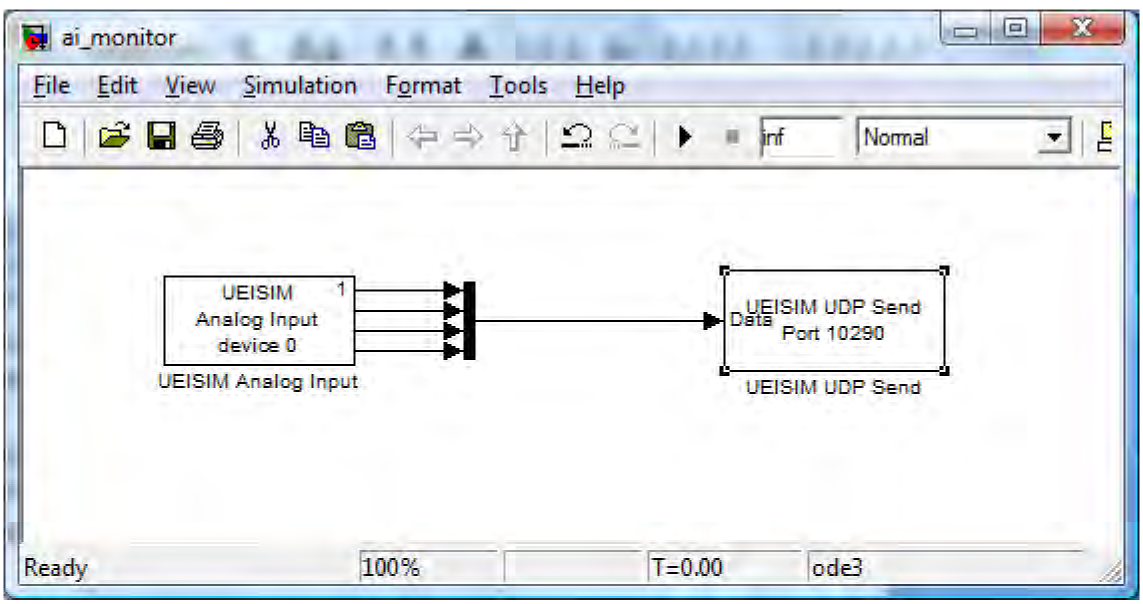
- **Byte alignment**: The minimum number of bytes occupied by each member. Possible values are 1,2,4 and 8. For example with align=4, **int8** and **uint8** members will occupy 4 bytes with 3 zero bytes for padding.

The block displays one input port to connect a **uint8** vector coming from the UDP Receive block. The block automatically converts itself to one with the correct number of output ports.
The UEISIM TCP/Ip or UDP Receive block needs to be configured to receive a vector of type **uint8** whose dimension is the size occupied by all members defined in the unpack block (in bytes).

### 5.14.4. UDP example

The following example acquires analog input channels and sends over the result to a network host.




The following example sends simulated data and receives it too (IP address must be set to 127.0.0.1).

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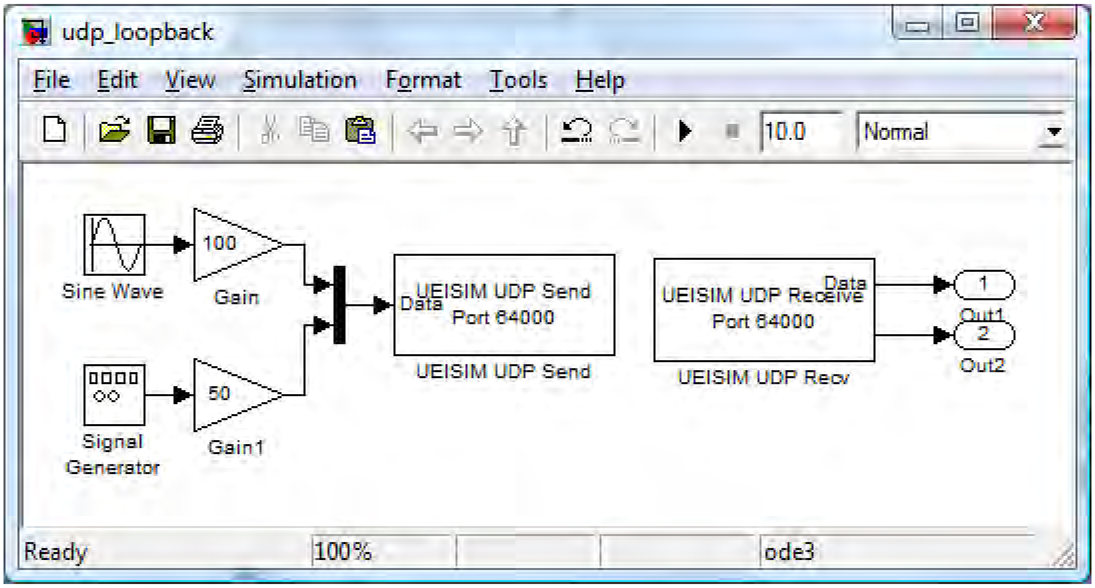
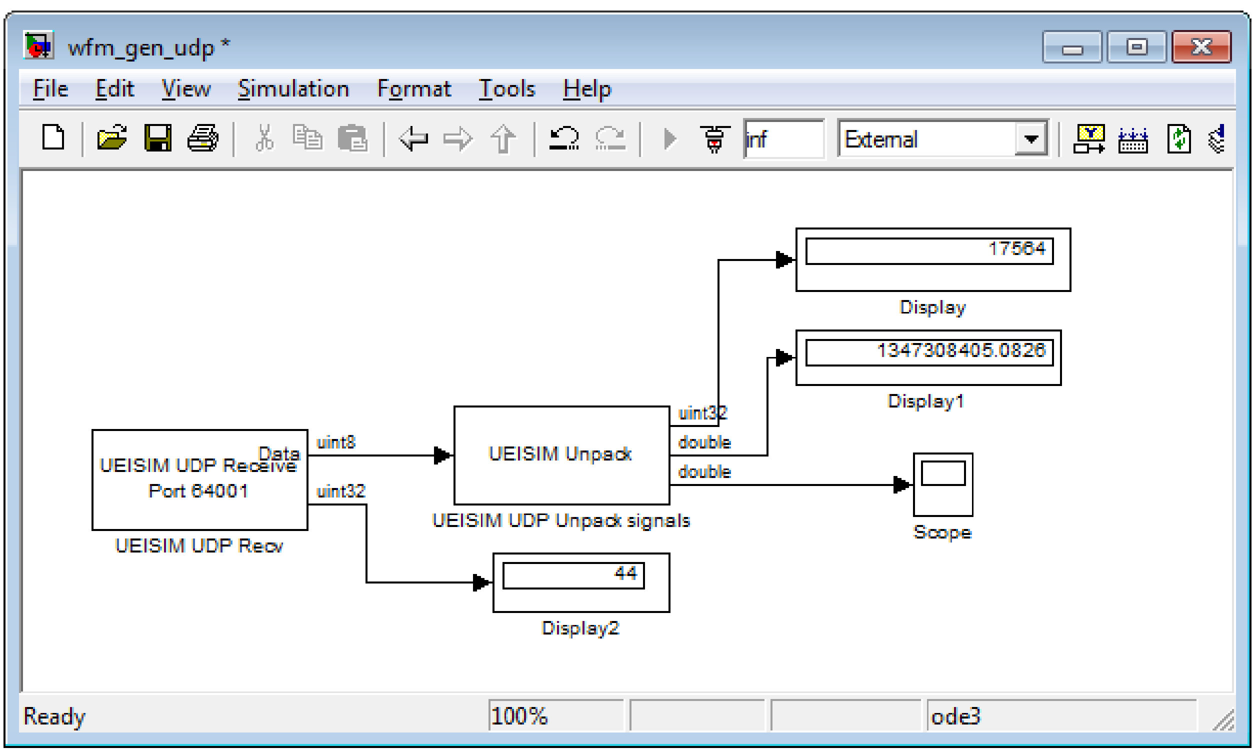



The following example receives 44 bytes from UDP port 64001 and decodes them as one uint32, one double and a vector of 4 doubles.



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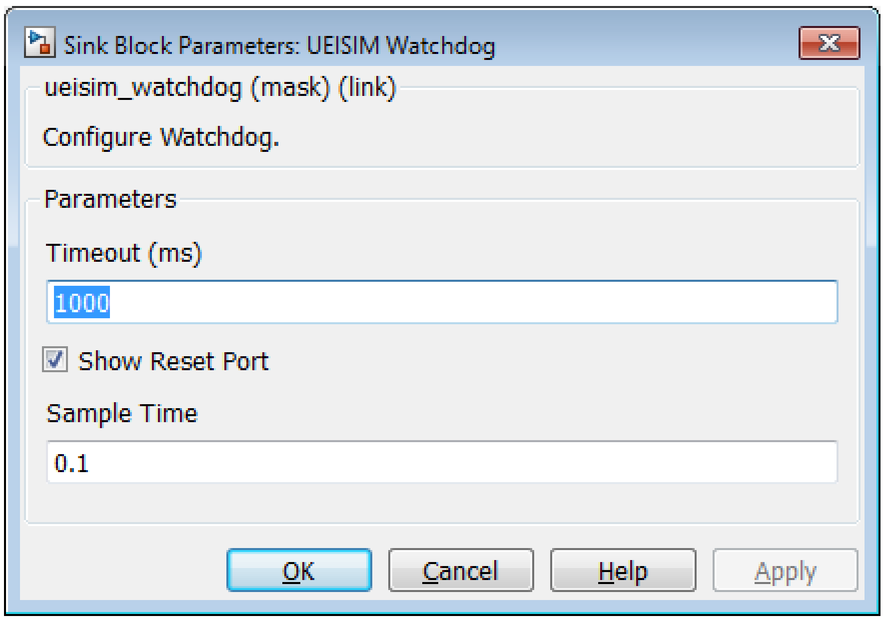
## 5.15. Miscellaneous

### 5.15.1. Watchdog block

A hardware watchdog can be configured to reboot the UEISIM if the model hangs or takes too long to complete a step.




- **Timeout**: The watchdog timeout delay in milliseconds. UEISIM will reboot if watchdog isn't reset before timeout expires.
- **Show Reset port**: Allows to optionally connect a reset signal
- **Sample Time**: The rate at which the block executes during simulation

When **Show Reset Port** is checked, this block displays an input port for connecting a reset signal. The watchdog resets whenever the input signal value is greater or equal than 0.5.
Otherwise the watchdog is reset each time this block is executed.